

1911.

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WESTERN AUSTRALIA.

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The Western Australian Institution of  
Engineers.

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INAUGURAL ADDRESS

BY

JAMES THOMPSON.

B.E., M. Inst. C.E.,

PRESIDENT.

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31st MARCH, 1910.

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# THE WESTERN AUSTRALIAN INSTITUTION OF ENGINEERS.

*Inaugural Address by the President,*

JAMES THOMPSON, B.E., M. INST. C.E.

31st MARCH, 1910.

GENTLEMEN,—

I highly appreciate the honour you have done me in electing me first President of the Institution of Engineers of this State. It is a position which, more especially in its early stages, entails work and foresight, in order that the course of the Institution may be directed into right lines, and that it may eventually become recognised as one of authority on Engineering matters. It will be my endeavour to justify the trust you have placed in my hands, and when I surrender this chair, at the end of my term of office, I trust that the dignity of this Society will not have suffered, and its usefulness will have been made manifest. No less than your President, your Council and Officers must display interest and enthusiasm in advancing the Society; but the inspiration must come from the members themselves, for without the earnest and continuous co-operation of you all, the Council can do no more than initiate—the Society as a whole must carry on the work.

In my address to-night I propose to bring before you the early Engineering history of this State, so that the struggles of the profession, and the lessons to be derived from them, may not be lost to posterity. There is no little interest and much romance attached to pioneer Engineering in a new country. For the greater part of this early information I am indebted to the kindness and research of the Government Statistician, Mr. Malcolm Fraser, and his officers, who have spared no pains to make it as accurate as possible.

The first Civil Engineer in charge of Works here was Mr. Reveley, who was brought from the Cape of Good Hope in 1829 by Governor Stirling. Mr. Reveley, it seems, was a friend of the Poet Shelley, in whose letters his name appears. He was appointed to the position of Civil Engineer in May, 1829, with no remuneration. A copy of his letter of appointment together with instructions, are worth reading to you.

Colonial Secretary's Office,  
16th May, 1829.

From Peter Brown, Esq.,  
To H. W. Reveley, Esq.

Sir,

I am directed by the Lt.-Governor to acquaint you that he has nominated you to act as Civil Engineer to the settlement, and to require that you will forthwith take upon yourself the fulfilment of the duties of that Office, taking for your guidance therein such instructions as you may from time to time receive from this Office. In accepting this appointment you are, however, to understand that no salary will be attached to it until the circumstances of the settlement shall lead to a more regular establishment of all the Offices under Government.

I am, yours, etc.,

(Sgd.) P. BROWN,  
Secretary to Government.

*Copy of Regulations relative to the Department of the Local Engineer.*

1. The Civil Engineer is to prepare plans and carry on such works as his instructions from the Lieutenant-Governor received from time to time may point out.
  2. He is to superintend the conduct and command the services of all persons filling situations in his Department, reporting to the Lieutenant-Governor if there should appear any remissness or inefficiency on the part of the persons so employed.
  3. He is to have the following books kept in his Office:—
    - (1.) A Diary:  
of every person employed by him, and a notification thereon of every document issued or received.
    - (2.) An Account Current Book:  
for entering the receipts and expenditure of all stores in his charge.
    - (3.) A List Book:  
for the entry of Public Works in full progress, showing the amount of labour and materials as they are expended thereon.
  4. He is to keep the following forms:—
    - (1.) A Monthly Abstract of wages due to persons in the Department.
    - (2.) Of Estimates and Reports.
  5. He is to preserve carefully all documents whatsoever relating to the business of his office, whether such may be the copies of letters or other documents received or issued, noting them with the numbers they may bear on the Register of his Diary above mentioned.
  6. He is to submit the three books above mentioned to the inspection of the Lieutenant-Governor on the first of every month.
  7. All applications or reports to the Lieutenant-Governor to be made through the Colonial Secretary's Office.
- Western Australia, 18th June, 1829.

(Signed) JAS. STIRLING,  
Lt.-Governor.

By Command of His Excellency,

(Signed) P. BROWN,  
Secretary to Government.

Sir,

I have sent you, by command of the Lieutenant-Governor, the Regulations relative to the Department of the Civil Engineer.

(Signed) P. BROWN,  
Secretary to Government.

H. W. Reveley, Esquire.

In January of the following year he received the large salary of £100 per annum, with Travelling Allowance, when away from Perth, at a guinea per day. Some years later this was increased to £200 per annum. He held the position of Civil Engineer for three years, when he resigned and accepted that of Superintendent of Public Works, which he retained until he severed his connection with the Colony at the end of 1838, when he was succeeded by Mr. Trigg.

*Roads, etc.*

Naturally the first thing in a new country to receive attention is roads, and no doubt the first was that between Fremantle and Perth, although there is no specific



reference to it except that, in 1837, a small sum was granted for improvements. The original access between these two places was by ferry at Preston Point, and by a track following somewhat the existing road, but entering Perth over Mt. Eliza on the line of the present main drive through the Park.

The rates of charges at the ferry were as follow:—

	s.	d.
Each person .. .. .	0	6
Each horse, mare, foal, cow, calf, ass, etc. .. .. .	1	6
Each sheep or goat not exceeding 20 .. .. .	0	2
Each sheep or goat exceeding 20 .. .. .	0	1½
Each pig .. .. .	0	4
For every 2-wheeled carriage .. .. .	2	6
For every bushel of grain .. .. .	0	1
Luggage, at per 100lbs. .. .. .	1	0

In 1834, by proclamation, ferries were established at Ferry and Preston Points, Fremantle, Mill Point, Perth, and Guildford. Settlement was active in the South-Western District and round Toodyay and York, and there are many mentions of roads being cleared and bridges constructed over the various intervening water-courses not fordable. In 1837 the direct road between King George Sound and Perth was opened up, the Swan being crossed either at Guildford or Mill Point by ferry. In 1869, 300 miles of road had been grubbed, cleared, formed, and drained on the main lines of communication from Perth to York, Northam, Victoria Plains, and Gingin, and for 250 miles the roads had been metalled and gravelled to an average depth of 15in. with a width of 18ft. and five miles of road had been formed with wooden blocks.

To Albany the road had been formed for 240 miles, and in the vicinity of Busselton 106 miles of road had been made, and nearly 100 miles between Pinjarra, Bunbury, and the Blackwood, and 110 miles in the Champion Bay District. By the year before mentioned over 1,100 miles of roads had been constructed, the greater part of them by convict labour.

Water carriage is, of course, one of the cheapest forms of conveyance for produce, and great trouble was experienced between the Upper and Lower Swan, owing to the shoal water at the "flats," now the "Causeway." In 1831 tenders were called for cutting a canal across the shoal water connecting the deeper reaches on each side, and the notice calling tenders reads as follows:—

#### PUBLIC NOTICE.

Sealed tenders will be received at this office on the 15th March next for cutting through neck of land which connects Mr. Camfield's grant with the mainland, in order to form a canal of communication between the back water on this side of the island with the deep water of the river on the other. The entire length of the cut will be 275 yards, 180 of which will be 4ft. deep and the remainder (95 yards) with an average of 8ft. deep, the breadth of which will be 12 feet in the clear at the bottom. The land to be cut through consists principally of clay, the rest sand.

2. Tenders may either be for the whole contract complete, or by measurement.

3. The plan to be seen and all information obtained by application to the Civil Engineer, Perth, February 23rd, 1831.

I have had the position of this canal marked on a lithograph for the general information of members (Drawing No. 1). This, as far as I can ascertain, is the first notice of the sort extant in the Colony.

It is worth while noticing that, even at this early stage in the Colony's history, strikes were not unknown, from the following report by the Engineer:—

John Crane in the *name of the Contractors for cutting the canal* gave me formal notice of their intention to strike work from this date, 4/6/31.

Apparently this strike was settled, because a final certificate is put forward in August of the same year by the Civil Engineer, of which the following is an extract:—

The canal measured, when complete, 834ft. long by an average top width of 26ft. and with a width of 12ft. at bottom; the depth varied from 2ft. 6in. to 17ft. 4in. The excavation amounted to 4,255 cubic yards, and it took seven men 107 days to do the work. The original estimated quantity was 3,000 cubic yards. Payment for the extra quantity was referred to the Governor for adjustment, who allowed 2/3rds of the contract price for this quantity, namely, 13½d. per cubic yard as against 1/8d. schedule rate.

He was a wise arbitrator who gave no reasons for his decision. Wages at that time were at the rate of 5s. 6d. per day for ordinary labour, leading men obtained 6s. 3d. This undertaking does not appear to have been very successful, as in the *Perth Gazette* of 16th February, 1833, the following paragraph appears:—

We understand it is in contemplation to make another attempt to render the "flats" above Perth navigable, and tenders for the completion of the projected undertaking will appear in our next number.

The inconvenience the settler has experienced during the summer renders this an object of serious importance. We are glad, however, to find it has been taken into consideration, and advanced to this preparatory stage.

This appears to have been a scheme by Mr. Reveley to confine the water to the canal or channel by blocking the lateral channels between the Islands by means of dykes.

Agitation was then made to form a Causeway, and so connect the King George Sound and South-Western roads directly with the Capital, but a commencement was not made until 1840, and it was not completed till 1843, the estimated cost for the bridges and banks being £1,800. Since then there has been very little cessation of work on the Causeway—the original estimated cost being exceeded many times.

Before leaving Mr. Reveley, who, as already mentioned, retired in 1838, it is interesting to find that the Governor in 1830 asked him for the particulars of a steam engine of 10 h.p. to pump water for the purpose of driving a water wheel 18ft. in diameter with which to grind corn. No estimated cost is given, but the details show that the boiler and engine were to be of copper; the reservoir to hold the pumped water 900ft. x 15ft. x 6ft. deep to contain enough water for 12 hours grinding, and the stones were to grind 12 to 15 bushels of wheat per hour. It is remarkable that such an early application of steam power should be mooted in a far away



and small colony in those early days. The mechanical efficiency of this peculiar combination, I am afraid, would not have been very high.

Mr. Reveley also owned a grant of land where the Technical College is now built. He there attempted, indeed more than attempted, he established a water mill to grind corn, but eventually found in summer time he could neither get sufficient water nor could he hold what he did get in his reservoir. This mill he had working in 1833. The mill pond was 170ft. x 80ft. x 8ft. deep, the bottom being at a depth of 17ft. below the general water level in the vicinity, and 36ft. above the level of the Swan. Every part of the mill was of colonial manufacture except the wrought iron, and made. Mr. Reveley states in his memorial to the Governor, "with colonial labour, which is more expensive than would appear, judging by the price of wages, as scarcely a working man here would perform much more than what would in England be considered half-a-day's work." He considered the mill proved that the colonial timber used in its construction was in every respect equal if not superior to any other known timber. This was his dictum in 1837.

#### *Bridges, etc.*

The first bridge of importance was that over the Canning River. It was commenced in 1849. The contract is a formidable document, furnished with numerous seals. The length of the bridge was 520ft., having a width of 12ft. with deck level 8ft. above common high water. In the deep water, "say, 150ft." (according to the specification) each pier consisted of four piles of "mahogany," which might be round but must be large enough to square to 12in. They were to be driven 8ft., or such further distance as might be required, for which a *fair allowance was to be given by the Superintendent.*

In shoal water three piles were to be driven to each pier, and these were to square to 10in. "Mud floats" are specified, which appear to consist of horizontal timbers bolted at ground level across the piers of the bridge. The distance between the ordinary piers was 12ft., but the centre pier had a span of 24ft. and was of peculiar construction, having two, what were called, "camber beams," with a rise of about 4ft. in the centre and joined to the straining beams by three vertical iron rods spaced 6ft. apart. The top of the camber beam was coincident with the top rail, and converted the two side stringers into bow string girders. This bridge of 520ft. was built by the Contractor, Solomon Cook, for £400, the progress payments being as follows:— $\frac{1}{8}$  in advance,  $\frac{1}{8}$  when the pier timbers were on the ground,  $\frac{1}{8}$  when the bridge was half built,  $\frac{1}{8}$  when the planking was laid, the remainder by debentures at six and twelve months bearing colonial interest. All the sub-structure of this bridge remained until two years ago. In 1892, in order to provide a navigation opening, the bridge was raised in the centre and ramped down on both sides. This was accomplished by merely adding a proportionate length to the piles in each pier.

Mr. Trigg, who was Superintendent of Works from 1838 to 1851, was the designer of this bridge, and he characterises the workmanship on its completion as of "rough and unworkmanlike appearance." It seems to me to be a remarkable instance of cheap bridge construction, and one which we do not appear to parallel nowadays.



After the construction of this bridge the traffic between Perth and Fremantle went by the South side of the river and across the Causeway, where considerable improvements had been made by building bridges and embankments.

In 1864 the Fremantle bridge was commenced, convict labour being largely employed.

The length of this bridge was 954ft. x 12ft. wide. The cost, so far as I can ascertain, was £3,114. On its completion, improvements were commenced to the road on the North side of the river between Fremantle and Perth, which has since taken the place of the longer route by the South side.

#### *Waterways, etc.*

From roads one naturally turns to waterways as a means of communication, and in this respect the small colony did what it could to assist the settlers in providing suitable water carriage for their goods.

The small cut already referred to across Burswood Island was extended down river nearly a mile in 1834. The bottom width of the channel was 14ft. The Islands on the side of the back water bordering on what is now Victoria Park were connected by dykes right across to the mainland at the bottom of Hay Street. This, of course, was to concentrate the water into the cut, and produce, as far as possible, a natural scour. The dykes apparently lasted for some time, as there is a notice to the public in 1842 that a bar had been placed across the dykes to prevent horsemen using them, as injury to them had occurred from this cause. The price of this work was £350.

The Civil Engineer in 1837 was asked to report as to the best position for a Government wharf at Fremantle, the choice was between South Bay and Bather's Bay. He chose Bather's Bay, as by means of a tunnel from High Street easy access could be obtained to the town, and, furthermore, deeper water would be obtained at a less cost than by adopting South Bay for the jetty site.

So far as I can ascertain, no Government jetty was built here, South Bay being eventually selected.

The Whaling Company had obtained a grant on the foreshore at Fremantle, where he had previously recommended the site of the jetty and had commenced building a stone jetty; later on they offered to make the tunnel through to High Street if the Government gave them prison labour; this was done, and the tunnel constructed at the Western end of High Street by the Company.

The values of the works put up by the Whaling Company was estimated at the following:—The tunnel, £250; wharf and jetty, £400; timber caisson filled with stone at the end of the jetty, £300.

In 1839 the canal at the back of the present Association Cricket Ground was excavated at a cost of £250 by one John Crane, who afterwards became the first toll-keeper on the Causeway bridges.

So long ago as 1836, a sea-going craft was built at Fremantle and called the "Lady Stirling." In the following year a jetty 75yds. long was constructed at Albany, 6ft. wide, with piles 4ft. into the ground; the spans were 3ft. with three piles to each pier; joists were laid across the piles and trenailed through; on this



was laid 3in. decking. The contract price was £100, a remarkably cheap piece of work.

In 1855 a screw steamer called "Les trois Amis" commenced running on the Swan between Fremantle and Guildford, and two years later came the second "Lady Stirling," an iron paddle steamer sent out in sections, and erected here by Mr. Jos. Harwood.

In 1868 there is an appropriation of £3,931 for a steam dredge. The dredge was ordered from Messrs. Maudsley & Son, for the sum of £2,890. Freight, cost of erection in the Colony, and other charges brought the total cost to £4,279. She arrived in 1870. The dimensions were—length 90ft., breadth 19ft., depth 8ft. This was the old "Black Swan," which has worked for many years on the river. It was originally manned by a party of prisoners under the charge of a warder and coxswain. The cost per yard for deepening the channel worked out at 9 $\frac{3}{4}$ d. The old vessel, after an honourable career of 40 years, was broken up two years ago, but the engine is still an excellent piece of machinery.

### *Jetties.*

Up to 1869 the following jetties had been built:—

Albany,	length	555ft.	with	4ft. of water at ordinary tides.
Bunbury,	"	1,400ft.	"	11ft. " "
Busselton,	"	500ft.	"	10ft. " "
Champion Bay,	"	300ft.	"	9 $\frac{1}{2}$ ft. " "
Fremantle,	"	1,470ft.	"	head of 90ft. x 55ft., and into a depth of 11ft.
Total	..	4,225ft.		

### *Lighthouses.*

Intimately connected with harbour improvements is the question of installing lights. These were not forgotten, and in 1842 the foundation stone of the old Rottnest lighthouse was laid, but it was some years afterwards before it was finished, the work being done, so far as I can ascertain from the records, by prison labour working under the Superintendent of the Island. The value of the work done up to 1847 was £1,070. It was not then quite finished, and the cost of the lighting apparatus is not included in that sum. The notice to mariners was as follows:—

A revolving catoptric light will be exhibited from the lighthouse near the centre of Rottnest Island on and after the night of the 1st June, 1851, during the period between sunset and sunrise. The lighthouse is a white stone tower 53ft. in height erected on the summit of the island, and is surmounted by a lantern 11ft. high. The light will consist of two groups of three powerful lamps each, the whole revolving once in two minutes, and showing a flash of light of five seconds duration, with intervals of 55 seconds of darkness. The centre of the light is 197ft. above high-water mark, and at the height of 18 feet may be seen in clear weather at a distance of seven leagues.

The lamps were plain copper oil vessels with chimneys, set in parabolic reflectors. There were no lenses.

On the same date notice was given that a light would be exhibited from Arthur Head at Fremantle 92ft. above high-water mark, and visible from a height of 18ft. five leagues distant.

It may be here stated that on the 17th March, 1896, the old Rottneest lighthouse was discontinued, and a new lighthouse came into use. This is a first order, white, revolving, dioptric light placed on a stone tower 100ft. high, the focal plane is 112ft. above ground level, or 264ft. above high-water mark, and is visible 23 miles all round the horizon. The light is eclipsed for 17 seconds, and visible three seconds; the approximate cost was £8,200.

At the end of 1879 a new lighthouse was erected on Arthur Head. This was an elegant stone column 71ft. from base to vane of lantern, the focal plane being 92ft. above high-water mark. It had a third order, fixed, dioptric light, and was visible for about 16 miles from the deck of a vessel. In 1904 this was taken down to make room for the fort, the stone being used in that structure. The old light is now exhibited on Casuarina Point, Bunbury.

Early in 1858 the Breaksea Island Lighthouse was built. It was a second order fixed white light 383ft. above sea level, visible, as stated in Notice to Mariners, at a distance of nine leagues. The tower was of iron, octagonal in shape. The principal work of this lighthouse was done by convicts, in charge of a sergeant of the Royal Engineers under Captain Wray of the same corps. This officer did not agree that the iron tower was the most suitable, but would have preferred stone as being cheaper and speedier to build, but carried out the design of the Colonial Lighthouse Engineer attached to the Board of Trade. He estimated the cost for the stone quarters and erection of tower at £638. I may mention that this light has been modernised, as in 1904 the tower and light were removed to make room for a stone tower, having a first order light. Separate stone quarters have been erected for the keepers, and many other improvements effected. The old lantern and light have been recently erected on Cape Inscription at Dirk Hartog Island, and, after several years' disuse, is now again directing the mariner, with this difference, however, that where, previously, the lamp consisted of oil burners and wicks, an incandescent burner has been installed, much increasing the brilliancy.

In the same year (1858) a light was also exhibited at Point King, at the entrance to Albany harbour. It was also a fixed white light of small power, and was carried on a wooden square tower elevated about 37ft. above high water; the light is still in use.

In 1878 a lighthouse was erected on Point Moore, near Geraldton. This is a round cast iron tower 21ft. in diameter at the base. The upper light is a second order, dioptric, white light giving a flash every 40 seconds and visible for about 18 miles from the deck of a vessel. There is also a fixed red light of the fourth order exhibited over dangers adjacent to the Point. The cost of this lighthouse was £8,000.

#### *Fremantle Harbour Works.*

As the improvement to Fremantle Harbour is of great interest and large importance, I have dealt with it separately.

In one of the early dispatches of Governor Stirling he states that if the narrow neck of land between Rocky Bay and the sea were cut through, Melville water was of sufficient size to float the British navy. In those days Melville water also included Freshwater Bay.



In 1837 Lieutenant Jones suggested to Governor Stirling that a safe harbour at Fremantle might be made by running out a breakwater towards Garden Island from the South-West side of Arthur Head for about 600yds., then bend Southerly towards Woodman's Point for a distance of 300 to 400 yards. The enclosed area would safely accommodate vessels from 300 to 400 tons burthen. Larger vessels would have their legitimate anchorage behind Garden Island.

In 1839 the Surveyor General (Mr. J. S. Roe) submitted a scheme for a breakwater from the North side of Arthur Head and trending generally Southerly therefrom (Drawing No. 2). The depth of water enclosed reached a maximum of 16ft. only. Efforts were made in 1849 to open up the Bar at the mouth of the Swan River for small boats by blasting away the rock; but although something was done, the want of adequate plant apparently prevented the work from proceeding further. Then came the scheme by Captain Henderson, Royal Engineers, in 1855, who practically proposed the scheme suggested by Lieutenant Jones in 1847. This was followed by a somewhat similar but enlarged proposal, the second, by the Surveyor General, Mr. J. S. Roe.

In the following year Mr. Phelps propounded the first scheme for opening the river estuary. This consisted of confining the river for some distance from the mouth in a channel about 300ft. wide, and reclaiming the land North and South up to the retaining walls. The plan which I have here (Drawing No. 3) shows clearly the proposal he made. No estimate is given. You will note that no protective moles are indicated. This is an interesting plan, as it is one of the few dealing with improvements to the river estuary.

Mr. Doyne, the Consulting Engineer employed by the Colony in 1870, states in his report on the proposed deep water jetty, *inter alia*, "that the idea of concentrating the principal traffic of the Colony on Fremantle must be abandoned in view of the numerous natural difficulties to be contended with, and the consequent great cost and uncertainty of works undertaken for such a purpose."

In the early seventies improvements to Fremantle Harbour became a burning question, and various Boards, Commissions, and Select Committees were appointed from time to time by the Legislature to report on the matter, and numerous and divers proposals were the result. The difficulties in the way of forming a convenient harbour were considered so great and costly, in view of the small resources at that time of the Colony, that it was even suggested that Gage Roads should be abandoned in favour of Cockburn Sound, and the entrance to the latter improved accordingly.

The Select Committee reported in 1873 that "only as an ultimate resource would it be advisable to improve the entrance into Cockburn Sound."

The majority of the schemes proposed was for an outer harbour forming a breakwater affording shelter from the North-West and West, starting either from Arthur Head or Rous Head, the notable exceptions being those of Mr. E. Troode submitted in 1870 (Drawing No. 4) and Mr. A. J. Johnson submitted in 1873. I have had prints prepared of the former scheme, which is ingenious, comprising a species of floating breakwater off the entrance to the river, with jetty projecting from Arthur Head under its lee. The estimated cost was £5,600. This, I presume, was based on the use of convict labour. The other, that of Mr. Johnson, is the



only one contemplating a harbour in the river, and consisted of two moles giving a channel 200ft. wide between the Northern one projecting from Rous Head and the Southern one beginning at the bar itself. The depth of water proposed was 25ft.

The committee who examined the plan stated that it involved many engineering principles which they did not feel competent to solve. If from an engineering point of view the work could be carried out with a proper degree of certainty as to the results promised by the projector being attained, and if there were no likelihood of any further contingent expenses hereafter to maintain its efficiency (evidently thinking that dredging might be necessary), they were of opinion that the plan was worthy of consideration, as it placed the City of Perth in a most advantageous position as regards communication by water with the shipping. The estimated cost was £163,958, to be performed entirely by hired labour.

Two other plans considered by the Committee referred to in 1873 were presented by Mr. G. Randell (Drawing No. 5) and Mr. Bickley, the former projecting the breakwater in a South-Westerly direction from Rous Head, at an estimated cost of £14,755, convict labour being employed; the other proposed a breakwater from Arthur Head utilising the rock on the Head for construction purposes, and depending upon the sale of the area when levelled to recoup part of the expenses of the scheme. The estimated cost of this was £30,000, aided by convict labour. The Committee after examining this plan suggested an amendment, namely that a curved breakwater should be built from Rous Head to Beagle Reef, thus affording a much larger area of good anchorage and shelter to the mouth of the river. The Committee goes on to say: "but independently of the much greater expenditure which their suggestion would certainly involve, it would also involve what may prove to be the same objectionable engineering principles alluded to as requiring solution in respect to the plans submitted by Messrs. Johnson and Randell and consequently at this stage of the matter your Committee consider it inadvisable to recommend its adoption. Your Committee have in the course of their report referred to the engineering principles which have presented themselves to their minds during the investigation of the subject under review, and they have alluded to the recommendation of the Harbour Improvement Board as regards reference to some eminent marine engineer." They stated, "the principal of these difficulties is the question of siltage; whether any enclosed area such as would be formed by a solid breakwater would be affected by siltage, and whether the siltage would be more injurious in its consequences if such an area included the debouchment of the river than it would do. Southwards, in effect whether an area included within a breakwater projecting from Rous Head would be more likely to suffer from such cause than an area included within a breakwater projected from Arthur Head. Also whether, in either case, it would be necessary or desirable to have any opening in such a breakwater as a means of scour. Whether, in the case of Mr. Johnson's plans, the proposed inner basin would be likely to maintain its depth if excavated, as projected, to 25ft., the nature of the bed being sand, and such bed in immediate contiguity to the basin being of very inconsiderable depth, and whether the double mole leading to such basin would be liable to be affected in a similar manner; also whether the force of the sea during the North-Westerly gales would be liable to cause injury to the shores to the North-East of either breakwater unless protected



by extensive pilings, and particularly would the narrow, sandy isthmus to the North-East of Rous Head be more so affected were the breakwater projected from that head, than would be the land inside the bar were a breakwater projected from Arthur Head."

In 1873, Mr. Higginbotham, Engineer-in-Chief, Railway Department, Mr. Wardell, Inspector General of Public Works, Mr. Gordon, Chief Engineer of Water Supply, Victoria, were asked to report on the various schemes submitted. They stated that it would require a personal visit before coming to a conclusion, but as they had been asked to report without delay, they had formed the opinion, from the data placed at their disposal, that "forming a harbour at Cockburn Sound was the solution of the difficulty."

In 1874, on the 2nd of July, a Committee was appointed, which reported, on the 16th of the same month, on the plan proposed by the Victorian Government Engineers, and another one that was submitted by Mr. Nicolay. The Committee was unanimously of opinion that the site for any harbour works should be at Gage Roads. Mr. Nicolay's scheme was for the construction of a jetty and canal between the estuary of the Swan at Rocky Bay and the sea, and the Committee after having studied the matter, and heard the evidence of the Admiralty Surveyor thereon, was of opinion that it could not recommend the adoption of the scheme.

In the same year, apparently, permission was asked by Messrs. J. & W. Bateman, Wanliss, Connor, and McKay, to erect a floating dock at Fremantle. I regret I have been unable to trace the terms of the application, but it was moved in the Legislative Council, to whom the matter was referred, that on the completion of a floating dock in the port of Fremantle capable of lifting a vessel of 1,000 tons burthen, interest on the amount expended on the construction thereof in accordance with plans, specifications, and estimates to be approved by the Governor, be guaranteed at the following rates and on the undermentioned conditions:—

"For the first three years such sums as may make the net profit of the capital expended equal to 8 per cent. per annum thereon.

For the succeeding 12 years, such sum as may make the net profit of the capital expended equal to 6 per cent. thereon per annum.

The guarantee to stop at any time that the dock ceases to be in a thoroughly serviceable condition, or is not opened to the public nor in accordance with a tariff approved by the Governor."

After debate the question was referred to a Select Committee. After waiting some time the Chairman of the Committee reported that consequent on no definite information as to the proposal being obtainable from Messrs. Bateman and Co., the Committee were unable to make any recommendation. And so the matter ended, not to be revived until some 30 years had elapsed, when it was brought up as something quite new!

In 1875 Mr. Wardell, Inspector General of Works, Victoria, one of the members of the Victorian Board who reported in 1873, after a *personal inspection* of the harbour, made a report upon the proposals to provide accommodation for first class vessels, by which term he signifies steamers drawing 24ft. or 25ft.

He was positive that any solid work projecting from Rous Head or Arthur Head would arrest the littoral drift and be certain to shoal the anchorage. He



also considered that any money spent in opening a larger channel into the river by blasting the rock-bar or otherwise would be thrown away, for a sand bar outside would inevitably follow. For similar reasons he condemned the proposed canal from Rocky Bay to the ocean. He concluded that the only means of making an anchorage safe and accessible in all weathers was by the construction of a breakwater on the West side of Gage Roads and detached from the main land. As he considered no fitting material for such a breakwater was available in the neighbourhood, he proposed to use concrete or beton blocks of 15 to 20 tons each, deposited as *pierres perdues*. His estimate, which he said was necessarily very rough, amounted to £857,700, exclusive of two mole lights and removal of rocks.

In the same year a scheme was put forward by Mr. T. H. J. Browne (Drawing No. 6). This contemplated a cut through the narrow neck North of Rous Head into an enclosed basin divided from the main river. The cutting was protected by two breakwaters, one on the North side extending some distance and curving Southwards, the other, a short one, extending Westerly from the South side of the entrance of the canal. His estimate for the cost of this work was £120,000, but Mr. Malcolm Fraser, Commissioner for Works, reported that it could not be done for less than half a million.

The general scheme was considered to be attractive, but foundations for any wall inside were considered so bad as to condemn the whole scheme.

In December, 1875, another Select Committee was appointed, who reported that Mr. Browne had sent in amended plans, and whilst considering the scheme meritorious were of opinion it was too expensive and costly to warrant adoption by the Colony at the present time. They further agreed that, provided no unforeseen engineering difficulties were hereafter made apparent, the projection from Point Marquis (which is almost identical in position and general direction with that designed by Captain Henderson) should be adopted, and that the breakwater should be built of timber (Drawing No. 7). They were reluctant, however, in advancing this scheme, as it virtually abandoned the first intention, which was that ships and steamers of the largest class must be accommodated.

In 1875 the whole matter was submitted to Sir John Coode, who reports in 1876 that, with the data at his disposal, he is only able to give an opinion as to the general character of the works that could be expected, and asks for a large amount of further information.

In November, 1877, Sir John Coode, after having received additional information, reported that he had carefully considered the matter, and come to the conclusion that with the small rise and fall of the tide at Fremantle it would be impossible to have sufficient scour to retain an efficient depth of water in a sandy harbour at the mouth of the river. Furthermore, any solid projection from the coast line, in his opinion, by stopping the littoral sand drift, would eventually silt up. He proposed two designs (Drawing No. 8).

(a.) A viaduct 2,600ft. long running in a North-Westerly direction from Rous Head towards Eleanor Rocks terminating in 29ft. of water. The deck or platform of this viaduct would be 15ft. above high-water mark, and the structure would be of a sufficiently open character to admit of the ready passage through it of the heaviest seas. From the end of the viaduct it was proposed to form a mound of



30-ton blocks of concrete resting upon a base of rubble to be obtained from the quarries near Fremantle. This breakwater would be of a total length of 2,600ft., composed of four arms placed at such angles as to afford perfect shelter to berths under its lee. It was further proposed to construct in the first instance an open piled jetty of 800ft. in length under shelter of this breakwater, having a depth alongside of 33ft. at low water, which would be available for berthage on both sides. There was also to be a wharf 700ft. in length with a depth of 29ft. at low water, which would likewise be available for berthage. A railway would be laid over the viaduct on the wharf and jetties, so as to afford perfect communication with the future railway systems of the Colony. The estimate was £638,000.

(b.) Provided works of minimum extent which could be relied upon to give satisfactory results of a permanent kind. This admitted the formation of an open timber viaduct of the character above described, 1,800ft. in length, extending in a West-South-Westerly direction from the Southward angle of Arthur Head towards the Beagle Rocks and terminating in 20ft. of water. At this point, and in continuation of the viaduct, it was proposed to construct an arm of solid concrete masonry 700ft. in length having a high sheltering parapet, thus answering the two-fold purpose of a breakwater and a sheltering quay. From the outer end of this solid work, an arm 800ft. in length was to be formed of jarrah piles, ties, braces, etc., filled in with rubble, extending in a southerly direction and terminating with a head and small lighthouse in 27ft. of water. There would be a quayage 1,800ft. long with from 20ft. to 27ft. of water at low tide. This work would have accommodated at that stage all but the largest class of P. & O. steamers; the estimated cost was £242,000. He expressed his regret at being unable to recommend the construction of any works for the sum of £100,000, or thereabouts, which the Council had named as the limit of expenditure that could at present be undertaken by the Colony.

This also occurs in his report—"I think it desirable to call attention to the final paragraph of the letter of the Director of Public Works to the Colonial Secretary, of 18th January last, wherein he states that the route of the railway connecting Fremantle with Perth should not be decided upon until it is known what is intended to be done in the way of harbour improvements. In the propriety of this course I entirely agree, more especially as I observe on one of the plans an indication of a proposal to construct an embankment and bridge to carry the railway across the river at a point about a quarter of a mile seaward of the present Perth road bridge; in view of the possibility of wharfage being constructed in that part of the river, whether in the near or remote future, I would suggest that the line should cross, if practicable, at some point *above* the road bridge, so that full latitude may be given for any possible future utilisation of the river frontage opposite the town."

In 1887 Sir John Coode furnished a further report, after personal investigation of the surroundings; *inter alia*, he states: "After re-consideration, now I have had an opportunity of personally examining the site, and of studying the further details which have been provided and which have tended to confirm the views expressed in my report of 1877, namely, that the conditions are so adverse that it is quite impracticable to treat the existing entrance to the Swan with a view to the formation and maintenance of a deep water approach from the sea with any degree



of success, and that any operations of this character, except to the limited extent to which I shall hereafter refer, would be attended with failure and disappointment."

The design he proposes at this stage is shown on the accompanying chart; the portion in red is estimated to cost £448,000, and was intended for immediate execution; that in brown in addition is estimated at £45,000 (Drawing No. 9.) These additional works, in the opinion of Sir John Coode, would have made the harbour a first-class mail boat station. No estimate is given for the works at the mouth of the river (shown in green), which in any case are only of moderate extent.

In view of the fact that the Orient Company promised to call at Fremantle if they had safe shelter, Sir John Coode was again asked for a report in 1891, and in compliance with the suggestion of Sir John Forrest, he reported: "There is nothing to prevent channels being cut across Parmelia and Success banks, thus forming a safe entrance to Cockburn Sound." He estimates the cost of cutting these channels at £214,500, including lightship buoys and lighting the channels.

Mr. O'Connor, then Engineer-in-Chief, commends on this report "that Owen Anchorage is much the better of the two, both as regards shelter and because it means cutting a channel through one bank only."

He urges finally that the whole question should be considered as being narrowed down to two distinct schemes (Drawing No. 9)—(1) Dredging a channel through Success bank and through shoal into Beagle Anchorage, and the construction of a jetty shelter thereto at Owen Anchorage, with railway from thence to Fremantle. (2) The attainment of an entrance into the river estuary either at the river's mouth or Rocky Bay by means of training walls, dredging, and the creation and maintenance of channel basins for navigation in 36ft. of water.

Finally, in December, 1891, Mr. O'Connor reports that he is of opinion that a harbour can be provided in the estuary of the Swan at a total cost of £800,000, having come to the conclusion that the amount of littoral sand drift, if any, can only be of insignificant character owing to the small rise and fall of the tide and diminished wave action.

The principal features in Mr. O'Connor's original scheme were the following:—

- (a.) The throwing out of two ocean moles from the North and South heads, respectively, of the river estuary to protect the entrance.
- (b.) The blasting and dredging of a channel 450ft. wide, and having a depth of 30ft. at low water, through the rock bar which formerly crossed the whole width of the estuary, and which, when the works were commenced, was mostly awash at low water.
- (c.) The dredging out, to a depth of 30ft. at low water, of an inner basin, about three-quarters of a mile in length, and 800 feet in width between timber quays constructed along both sides.
- (c.) The reclamation of about 48 acres of quay and warehouse space on the South side of the river, and of about 86 acres on the North side, making about 134 acres in all.



Needless to say, the scheme has been considerably enlarged since Mr. O'Connor's first report, the North Mole having been extended, and the inner basin having been increased in width from 800 to 1,400 feet.

The first load of material into the North Mole was tipped by Lady Robinson in 1892. The success of Mr. O'Connor's scheme is visible to all eyes. It is somewhat remarkable that the bug-bear of littoral sand travel should have been so differently estimated by these two eminent men, Sir John Coode and Mr. C. Y. O'Connor, more especially when one considers that the question of littoral sand drift had been studied and experienced by both on the New Zealand coast, where Sir John Coode had advised on, and built several harbours. The deliberate adoption of this scheme contrary to the advice of one so eminent in his profession as Sir John Coode is a monument to the sound judgment and sagacity of its designer. At the same time it should be mentioned that Mr. O'Connor always held that had Sir John had the same knowledge and data of the surroundings of Fremantle as he himself had, he would have come to the same conclusion.

### *Railways.*

Following on water carriage, one naturally turns to its great rival, railways. Of these the first line built in 1871 was a small tramway leading from the jetty on the coast at Lockville, six miles from Busselton, some 12 miles into the interior, to tap the timber country. The original locomotive used on this line is still lying a derelict at Lockville. This, as the first locomotive used in the Colony, is worthy of a better fate.

In 1872 a private tramway was constructed nine miles long from the Canning into the ranges, for the carriage of timber. There was also a small railway laid with wooden rails from Rockingham to the Darling Range. Iron plates 3in. x ½in. were attached to the rails at curves, and a speed of 15 miles an hour was attained.

It was not, however, until the 22nd of October, 1874, that the first sod of the first real railway was turned by Governor Weld. This was the Geraldton-Northampton line, built to develop the copper and lead mines at the latter place. The length of this line was 34 miles, and it was not opened for traffic until 1879. We can build railways somewhat faster than that nowadays. The total cost, including the purchase of land, was £146,631, or at the rate of £4,313 per mile.

One would have thought that there would have been considerable public discussion on the question of the most suitable gauge to adopt for the railways of the Colony, but I have not been able to find much of moment on this head. The gauge of the Geraldton-Northampton Railway was first fixed at 3ft., and a contract entered into on that basis for the construction of the line. This was approved by the Legislative Council, and sanction given to borrow money in 1873. It appears that after this had been done the Executive, in view of the fact that the light lines in the Eastern Colonies and the timber concessions lines in this Colony were built to the 3ft. 6in. gauge, altered the gauge of the line to 3ft. 6in. without consulting or informing the Council or making provision for the extra cost involved, estimated at £480 per mile. The Council naturally took umbrage, and appointed a Select Committee in 1875 to inquire into the whole matter. The Committee



agreed that the change in gauge was advisable, and that a number of other alterations were necessary, increasing the cost by about £900 per mile, but generally animadverted on the unsatisfactory conduct of the work. Thus was decided the standard gauge of the Colony, and at that it has remained ever since.

In 1874 proposals were made for railway construction between Fremantle and Guildford, by Mr. H. E. Victor (Drawing No. 10). The alternatives shown are (a) line by the North side of the river; (b) line on the South side of the river, with a connection with Perth across Causeway; (c) the entrance into Perth by South Perth and Mill Point.

In 1877 the then Director of Public Works, Mr. James Thomas, C.E., in a comprehensive report on the connection of Guildford and Fremantle by railway gives two alternative routes and two possibilities, practically on the lines proposed by Mr. Victor in 1874, the two main routes being on the North and South sides of the Swan River respectively. I am able to give a print of the plan accompanying his report (Drawing No. 11.)

The Northern route started from Fremantle on the river frontage on a line with Cliff Street, length 20m. 37c., and closely approximating to the position of the present line. It was proposed to cross the Swan at Fremantle by a timber bridge consisting of four 50ft. spans, and fourteen 30ft. openings, giving a clear headway of 20ft., 21 chains below the road bridge, and the Swan at West Guildford by a timber viaduct consisting of 27 openings of 30ft. each, half this width to be used for railway and the other half as a road bridge. The line on the South bank was 20m. 15c. in length crossing the Canning by a timber viaduct consisting of 61 openings of 33ft. each, Swampy Creek 19 openings of 20ft. each, and the Helena River 37 openings of 33ft. each. There was a branch from this line into Perth crossing the river a little down stream from the Causeway, two miles long, requiring a bridge of 72 openings of 33ft. each. His alternative to this was to make a station in South Perth connecting the City by a horse tramway 2½ miles long. This, Mr. Thomas considered, was tantamount to leaving the capital of the Colony out of direct communication with the port and the Eastern districts. These two routes are shown in red and blue on the plan.

The first possibility shown in dotted lines on plan was by leaving the Southern route near South Perth, and crossing the river somewhat further seawards than the proposed branch to Perth, then following along the river northwards and joining with the northern proposal at East Perth. This would only have opened up the Eastern end of the City. There was yet another possibility, that of adopting portion of the line from Fremantle on the Southern side and crossing from South Perth at Mill Point, skirting the Fremantle road where there would be a station, and then intersecting the City to join the Northern route. This would have required a very expensive bridge, and would have involved passing through some of the most valuable properties in Perth and intersecting the main thoroughfare.

Mr. Thomas's estimate for the construction of the two alternatives was for the North side £4,256 per mile or a total of £87,098, and for the South side £4,468 per mile including the branch to the City, or a total of £99,121.

After careful consideration he came to the conclusion that the line on the North side should be adopted, for the reasons that it would be "shorter, cheaper,



and afford a direct line which equally accommodated the Capital, port of Fremantle, and Guildford, these three towns having a combined population of just one-third (between 9,000 and 10,000) of the whole Colony. There would be but two large viaducts required, one at Fremantle and the other at Guildford, "the latter by making it answer the double purpose of a road and railway bridge would give the accommodation so much required between East and West Guildford."

In the same report he mentions the suggestion of a tramway worked by horse power, that would answer every purpose at present, and continues, "whilst however, acknowledging the great benefits that horse tramways confer in meeting the requirements of many districts, I could not recommend it in this case, for the present traffic fairly warrants the establishment of a better means of locomotion." He goes on to say, "it is not the cheapest line that costs the least money, but that which returns the best amount of interest on the capital expended, besides in this instance some portions of the road have gradients that would make it dangerous to work by horse power, and I can say this for locomotives that they are manageable in the darkest nights, are not liable to shy, take fright, or bolt off and get lost in the bush, can be tamed down by closing a valve, stopped by a brake, and backed by simply moving the lever."

He recommends for this line a gauge of 3ft. 6in., although had not the Geraldton-Northampton railway been built to this gauge, and also some of the timber lines he would have advocated fixing the gauge at 3ft., as being the most economical one to adopt.

The Government accepted Mr. Thomas's recommendation to carry the line on the North side of the river, and the first sod of this railway was turned by Governor Ord on the 3rd January, 1879, somewhere near the present William Street crossing, and was completed and opened for traffic on the 1st March, 1881, by His Excellency Governor Robinson. The total cost, including station buildings and land compensation, was £113,528, or at the rate of £5,705 per mile. In the same year a contract was let for its extension to Chidlow's Well. This was opened for traffic in 1884. In this year also a contract was let for the Albany-Beverley railway to Mr. Anthony Horden, Sydney, on the land grant system, also a contract for the continuation of the line from Chidlow's Well to York.

In the following year the construction of a line from York to Beverley was undertaken, and the Eastern Railway as far as York opened for traffic; also the construction of the line from Spencer's Brook to Northam was let to Mr. E. Keane for £13,427, or at the rate of £2,235 per mile.

In 1886 we have a contract signed for the construction of the Midland Railway from Midland Junction to Walkaway, on the land grant system; the Geraldton-Greenough Flats Railway commenced, and the line opened from York to Beverley and from Spencer's Brook to Northam. In the following year the Geraldton-Greenough Flats Railway was completed and traffic commenced.

At the end of 1887 a line from Bunbury to Boyanup was completed, but was not opened for traffic owing to the fear that a considerable loss would result. In the following year Mr. Hastie, a contractor of Bunbury, worked traffic on this line by horses, but neither made any profit nor satisfied the public. It was not until 1891 that this line was opened for traffic with locomotives.



In 1889 the line from Clackline to Newcastle was commenced, and the Roebourne-Cossack tramway built. In the following year the privately-owned line from Albany to Beverley was opened for traffic.

At the end of the year 1889 there were 188 miles of Government railways, and 519 miles of privately-owned railways opened for traffic, that is to say, since the commencement of the Geraldton-Northampton Railway in 1874, 651 miles had been built in the 15 years, which considering the small population, namely, 43,000, then in the Colony, was a very good record. The rest is modern history.

### *Water Supply.*

Of water supplies I can find little trace, the earliest allusion to public water works is in 1887, when steps were taken to obtain a water supply at the Fremantle gaol for the purpose of supplying shipping. Reservoirs were built in the gaol yard, into which water was pumped from the well supplying the gaol. As well as supplying the shipping, a certain amount of reticulation was undertaken; the cost was nearly £7,000.

In 1896 the Perth Water Company began to supply Perth with water. This was the result of an arrangement entered into by the Municipality of the City of Perth with a private company, based upon an arrangement to pay certain rates. The source of supply was the Victoria Reservoir, with a capacity of 200,000,000 gallons. The dam was built across Munday's Brook, near Kelmseott, of concrete, having a length of 750ft. with a maximum height from the foundation of 104ft. The greatest depth of water was 52ft., and the catchment area about 10,000 acres in the Darling Ranges. A trunk main 12in. in diameter led from the Victoria Reservoir to a storage tank on Mt. Eliza in the King's Park, having a capacity of 600,000 gallons. The scheme worked very well at first, but in 1896, owing to the considerable increase in the population, the supply became too small. The Government were then approached to take over the works, which, under the provisions of "The Metropolitan Water Works Act, 1896," were purchased at a cost of £220,000, and placed under the control of a Board. Since that date the supply from the reservoir has been largely supplemented by artesian bores.

At the present time there are 13,000 services, of which 8,700 are metered, the reticulation mains of cast iron; ranging from 12in. down to 3in. in diameter; the tubes of a lesser diameter attain a length of 187 miles, and there are also 30 miles of trunk mains ranging from 12in. to 21in. The net capital cost at present stands at £489,554, upon which there is earned interest at the rate of 6.44 per cent.

### *Telegraph.*

Telegraphic matters should not be neglected. The first telegraph line in the Colony from Perth to Fremantle was opened in the middle of 1869, and was built by private enterprise, but was acquired by the Government in 1872 for £12,000.

In 1871 the telegraph line was built from Perth to York and Northam. In the following year telegraph communication was opened up with Albany, and in 1874 to Geraldton. In 1877 telegraphic communication was opened up with South Australia. Then in 1885 came the telegraph line from Geraldton to Roebourne. This line was continued to Derby in 1889. In the same year Western Australia



was directly connected with the outside world by way of the Eastern Extension Telegraphic system by means of a cable from Banjoewangie to Broome, and finally Wyndham was connected up by telegraph in 1893.

In 1887 the telephone exchange system was inaugurated in Perth, one of our members being sent out from Home—not “for the good of his country,” but for the benefit of this State—to carry out the necessary work in connection therewith. Since then the expansion has been considerable.

### *Mining.*

The expansion of the Colony in recent years is so largely attributable to the mining industry that I cannot but make some mention of its history. As long ago as March, 1839, the Government had offered a grant of land of 2,506 acres to any person pointing out any considerable bed of coal in any part of the territory South of the parallel of the most Northerly part of Shark Bay and West of the meridian of Mt. Barren.

The first mineral discovery was by a shepherd near Northampton in 1842, where he discovered a copper deposit. This was profitably worked until the rush to the Victorian goldfields in 1850 caused a cessation of work owing to the impossibility of obtaining miners. So far as is known, these were absolutely the first mining operations ever conducted in Australia. Coal was discovered in 1846 on the Murray River, and a company organised to work it, but it was of such poor quality that the mine had shortly to be abandoned. The Geraldine copper mine was discovered in 1848, and was successfully worked for some years.

In 1852 several parties were despatched to the eastwards of York and Newcastle seeking for gold, but owing to the climatic conditions they were forced to abandon the search when at a short distance from the now well-known Yilgarn Goldfields.

In 1857 the Colonial Secretary, Mr. F. P. Barlee, in his yearly report, states: “Mineral indications abound in the Northern parts of the Colony, specimens (surface) of gold have been found, and there is but little doubt that gold will eventually be found in Western Australia to a large extent.”

The Government in 1862 engaged a practical miner, E. H. Hargraves, for a period of six months, to search for precious minerals throughout the settled districts of the Colony. Landing at Albany, he thoroughly prospected as far as Northam through the Darling Ranges. He made a very unfavourable report, stating that the formation of the area over which he had travelled was not indicative of the discovery of gold in payable quantities.

In 1869 the Government, being well aware of the benefit to the Colony of the discovery of payable gold, offered a reward of £5,000 for such discovery within 300 miles of any declared port of the Colony, to be paid after 5,000 ounces of gold had been shipped to Great Britain.

In 1872 rich copper and lead deposits were found near Roebourne, 60 tons being shipped from Cossack.

In 1873 a quartz reef was discovered at Kendenup, near Albany, and a company established to work it, but after several crushings the undertaking was finally abandoned.



In the *Year Book* of 1902-4, to which I am indebted for many of these particulars, the following little history is told:—

In 1880, Mr. E. B. Beere, farmer in the Toodyay district, brought to Perth a piece of ore, which he presumed to be a specimen of copper. The specimen was given to a business firm, and was for many years used as a paper weight. Then Mr. Lawrence, the well-known boat builder, secured it, and while in his possession Messrs. R. Greeves and E. Paine examined it, and at once pronounced it to be gold. Greeves was given about a pound weight of the stone, and from it he obtained six ounces of gold which he sold for £4 per oz. Greeves and Paine first saw the specimen in 1886, and immediately went in search of the locality from whence it had come. They were unsuccessful, but tried several times subsequently to locate Beere's supposed find, going over the Wongan Hills and Wyening runs formerly in possession of Beere. They reported finding gold at Wongan Hills, but no signs of rich reefs or alluvial deposits.

In 1882 Mr. Saunders reported by telegram that he "had found gold on the head watershed of the Ord River not payable. Believed payable gold existed. Auriferous country extends North-West and South-East of Forrest's track."

In the following year Mr. E. T. Hardman, Government Geologist, first visited Kimberley and reported the existence of auriferous country. In 1885, after another visit, he gave it as his opinion that gold existed in considerable quantities. In the following year a party of prospectors left, with the result that in 1886 the Kimberley goldfields were declared, and the first goldfields Mining Bill was passed.

In 1887 the Settlers' Association, with Government aid, fitted out a party to prospect the district to the Eastward of Newcastle and Northam. This party under the management of Mr. Colreavy went as far East as the Yilgarn Hills, but were unsuccessful on this occasion. Mr. Colreavy, however, was so impressed with that portion of the country that he returned on his own account, and found a small reef in Golden Valley. While he was at this place, H. Anstey brought rich specimens of gold quartz in from the same neighbourhood. Very soon numerous prospectors were on the ground, and Southern Cross Goldfields established. In 1888, tin was discovered at Greenbushes, and away in the North-West, at Mallina, near Roebourne, good reefs were discovered, and rich alluvial at Pilbara Creek, and the Pilbara Goldfields were declared. In the following year alluvial gold was discovered on the Ashburton River, and the rush continued to Southern Cross and to the Pilbara districts.

In 1890 a very rich copper mine was discovered at Whim Creek, about 50 miles East of Roebourne. From this at intervals a considerable amount of high-grade ore has been exported.

Coal in payable seams has only been discovered in recent years, as in 1898 the value of the product was only £1,761. This production has, however, increased, and for 1909 its value amounted to the respectable total of £90,965.

In 1891 came the Murchison gold rush, principally brought into notice by the reports of the then Government Geologist, Mr. H. P. Woodward. In 1892 Messrs. Bayley and Ford set out on a prospecting expedition to the North-East of Newcastle but they lost their horses and had to walk back. After some delay they set out to Southern Cross, and getting supplies there went out Eastward. After a



time they reached the native well at Coolgardie, and finding the place covered with grass they let the horses graze while they examined the flats. Here in a few hours they picked up 20 ounces of gold. They had to return for provisions to Southern Cross, but went back again. They, however, were tracked from Southern Cross, and soon afterwards the field was rushed. After this discoveries came apace, with the result that in these "way back" localities some of the finest mining machinery and gold-saving appliances in the world are to be found.

In 1886 the value of the gold production was £1,148, whereas for the financial year 1909 it was £6,766,274—all this in the space of thirteen years. The largest jump was between 1898 and 1899, when the production was valued at £3,999,698, and £6,246,732 respectively.

I have now briefly referred to the principal engineering works carried out by the Colony from its inception in 1829 until it assumed the responsibilities of self-Government in 1889—60 years later; the population at that time being under 44,000. During this period the Government practically absorbed all the engineering talent, the scope for private work being very limited. The construction of the Great Southern and Midland railways was, however, carried out by private enterprise, which employed its own engineers. Although considerable works had been projected, no large works had been achieved owing to financial limitations. It must have been a particularly trying time to an engineer with progressive ideas, little being capable of accomplishment, although much was needed. The engineer, however, like an ordinary mortal, "must cut his coat according to his cloth," and he is best who can obtain the greatest efficiency at the least cost, efficiency being the goal for which all engineers should strive.

Mr. Thomas, at one time Director of Public Works, in a report read to you to-night, very aptly states "it is not the cheapest line that costs the least money, but that which returns the best amount of interest on the capital expended," and this may be expanded to include most engineering works. Like most generalisations, this, however, must not be strained too much, as at times it is only possible to do a very small part of that which an engineer of foresight considers necessary to accomplish the greatest good.

From very small beginnings the Colony has progressed latterly with accelerated speed, and as far as I can see there is nothing to stop her accumulated momentum. The feverish excitement of the early goldfields rushes has given place to steady but persistent effort, and the comparatively slow but healthy development of the agricultural and pastoral lands is the best augury that Western Australia will ultimately take her place as one of the most prominent States of the Commonwealth.

### *Contrast.*

Here I may be permitted to sum up the advance made in engineering works by this State since 1869. At that date 1,100 miles of roads had been cleared, formed, and partly gravelled or metalled. Thirty-nine years later, apart from Municipal roads and streets, nearly 18,000 miles of roads had been cleared, formed, and partly metalled or gravelled.

As regards harbour works, in 1869 there were 4,225 feet of jetties in the Colony, somewhat less than a mile; whereas 40 years later (when the present ex-

tensions are completed in a few months time) there will be upwards of 36,000 lineal feet of jetties (exclusive of Fremantle), or nearly seven (7) miles in this State; a large mole constructed at Bunbury, transforming an open and dangerous roadstead into a safe and commodious harbour, and Albany harbour deepened to 33 feet.

Of lighthouses there were four:—Breaksea Island, Point King, Rottnest Island, Arthur Head. At the present date, 15:—Breaksea Island, Point King, Leeuwin, Cape Naturaliste, Busselton, Bunbury, Woodman Point, Rottnest (2), Point Moore, Cape Inscription, Babbage Island, Jarman Island, Bedout Island, Gantheaume Point; and the following are in course of erection:—Point Cloates, Vlaming Head, Cape Leveque. Furthermore, they are of incomparably greater power than the old lights which have been replaced.

Fremantle Harbour was non-existent, whereas there are now upwards of 6,000ft. of jetties having a minimum depth of water of 30ft.

Of railways in 1869 there were none, whereas there are now 2,039 miles opened for traffic (the capital cost being £11,017,000) and 281 miles in course of construction with nine lines to follow.

Water works were confined to wells, whereas now all the principal towns have some source of supply more or less efficient, and the great scheme of conveying water from the Darling Ranges to the Goldfields—one of the most remarkable schemes of the present day—has been completed. Numerous artesian bores have been sunk, successfully tapping hidden stores of water, and wells and dams constructed to aid the pastoralist and agriculturalist in his endeavours to render arid localities reproductive.

In telegraphic matters the expansion is no less marked. At the date mentioned there were 12 miles, whereas all the places of any importance are now linked up, the total mileage in operation being 6,868 miles.

Honour to those who have preceded us, and who by their example of sound and solid work carried on in the face of many difficulties, and who by their prudence and foresight, have aided the development of the Colony on right lines, and consequent on its expansion, and its need for members of our profession, have made it incumbent upon us to found the Institution of Engineers, before which there is a wide and noble work, embracing as it does members from all branches of the profession.

Let us one and all, old and young, strive to make it a success, ever having its objects before our view—the advancement of engineering knowledge and practice, the maintenance of a high professional standard amongst its members, and the promotion of the professional interests of engineers and the improvement of their status.

Gentlemen, I again thank you for the high honour you have conferred on me by electing me first President of the West Australian Institution of Engineers.



## W.A. INSTITUTION OF ENGINEERS.

*Plans accompanying President's Inaugural Address, 1910.*

Drawing No. 1.—Litho. showing Improvements to Swan River Navigation, 1830-1840.

Drawing No. 2.—Fremantle Harbour Improvements, by Surveyor-General J. S. Roe, 1839.

Drawing No. 3.—Fremantle Harbour Improvements, Scheme by Wm. Phelps, 1856.

Drawing No. 4.—Fremantle Harbour Improvements, Scheme by E. T. Troode, 1870.

Drawing No. 5.—Fremantle Harbour Improvements, Scheme by G. Randell, 1872.

Drawing No. 6.—Fremantle Harbour Improvements, by T. H. J. Browne, 1875.

Drawing No. 7.—Fremantle Harbour Improvements, Scheme by Select Committee of Legislative Council, 1875.

Drawing No. 8.—Fremantle Harbour Improvements, Alternative Scheme by Sir J. Coode, 1877.

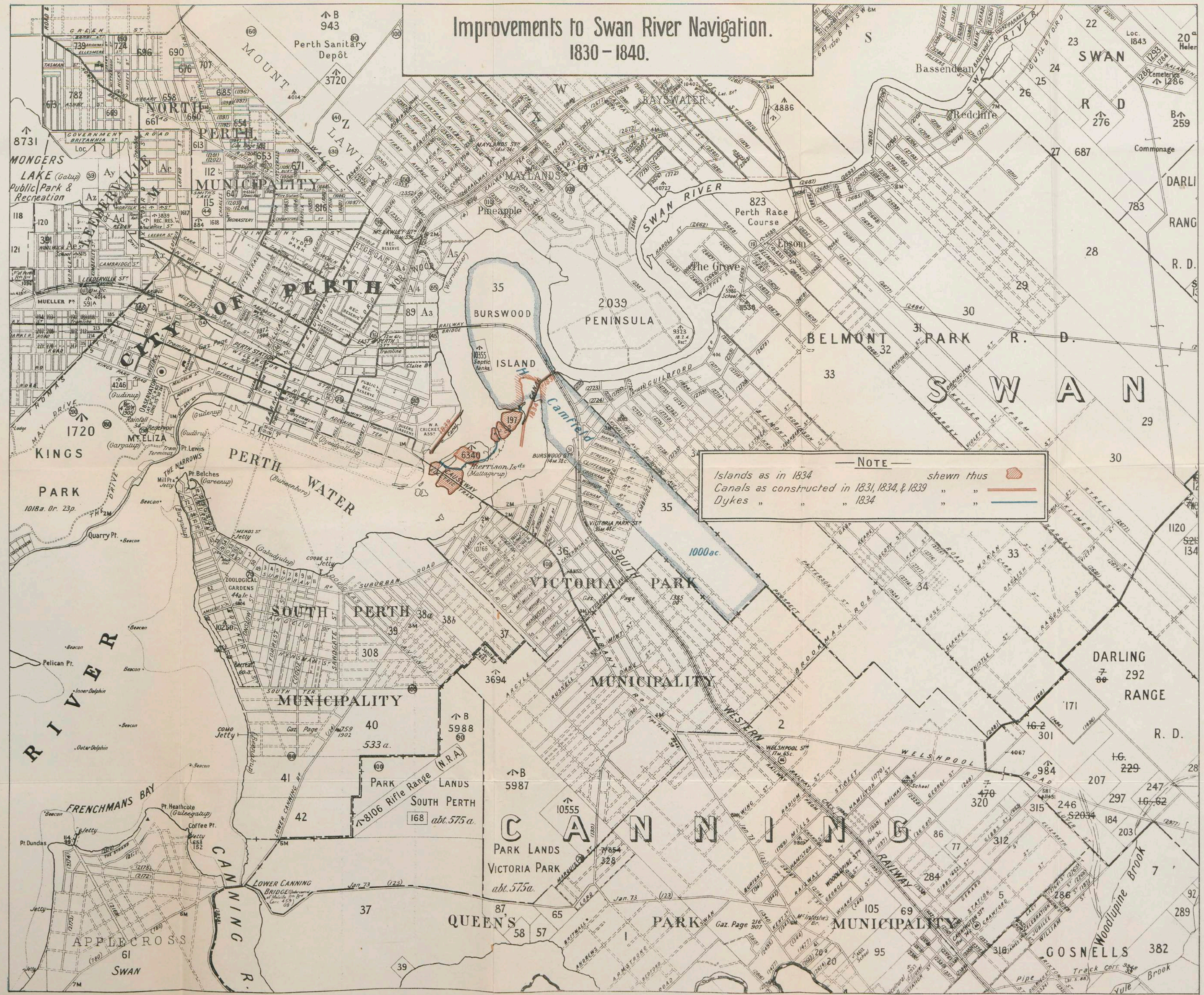
Drawing No. 9.—Fremantle Harbour Improvements, Chart showing final scheme, by Sir. J. Coode, 1887, and C. Y. O'Connor's scheme, 1892.

Drawing No. 10.—Fremantle-Guildford Railway, Alternate Routes, H. E. Victor, 1874.

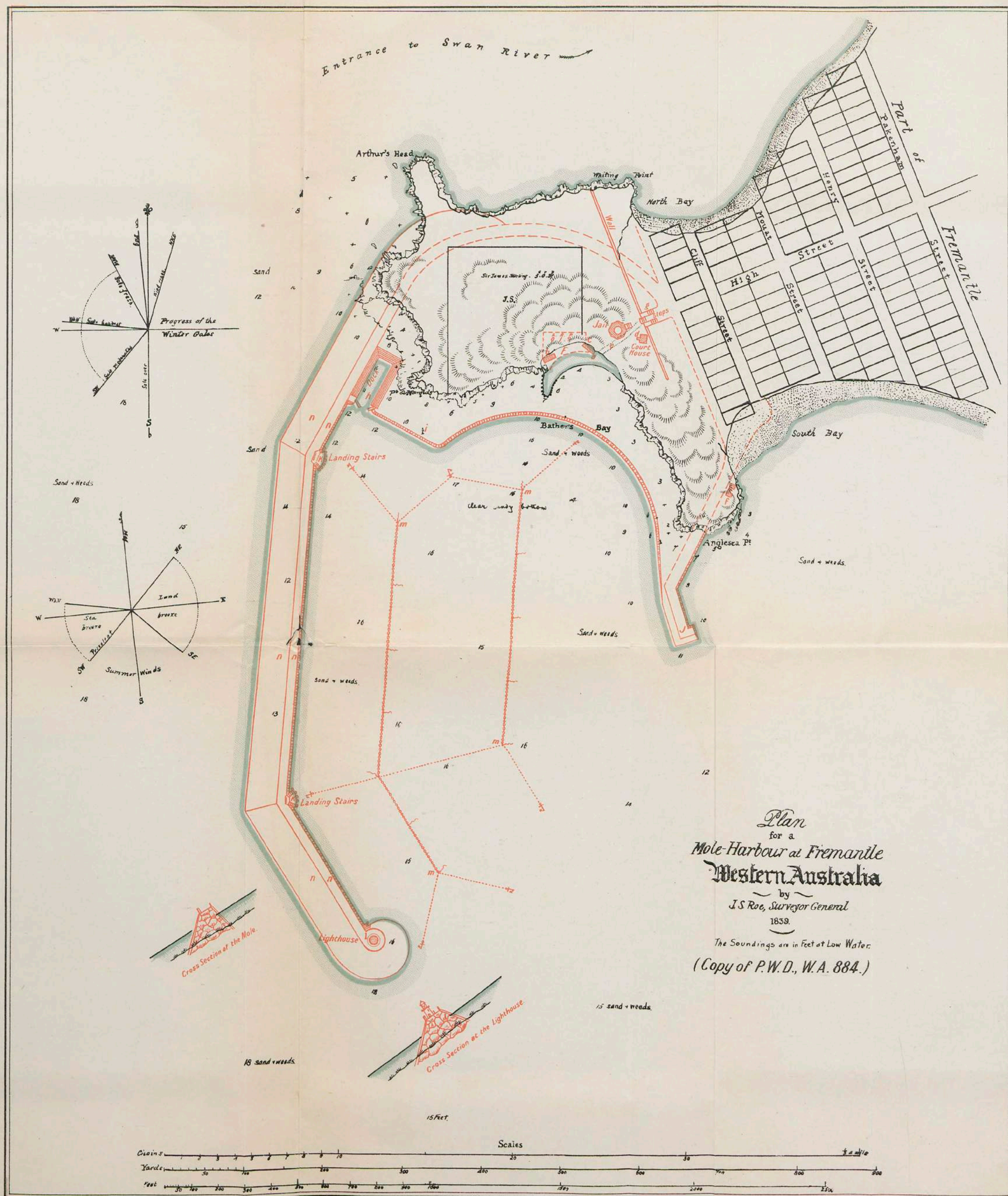
Drawing No. 11.—Fremantle-Guildford Railway, Alternate Routes by J. Thomas, 1877.



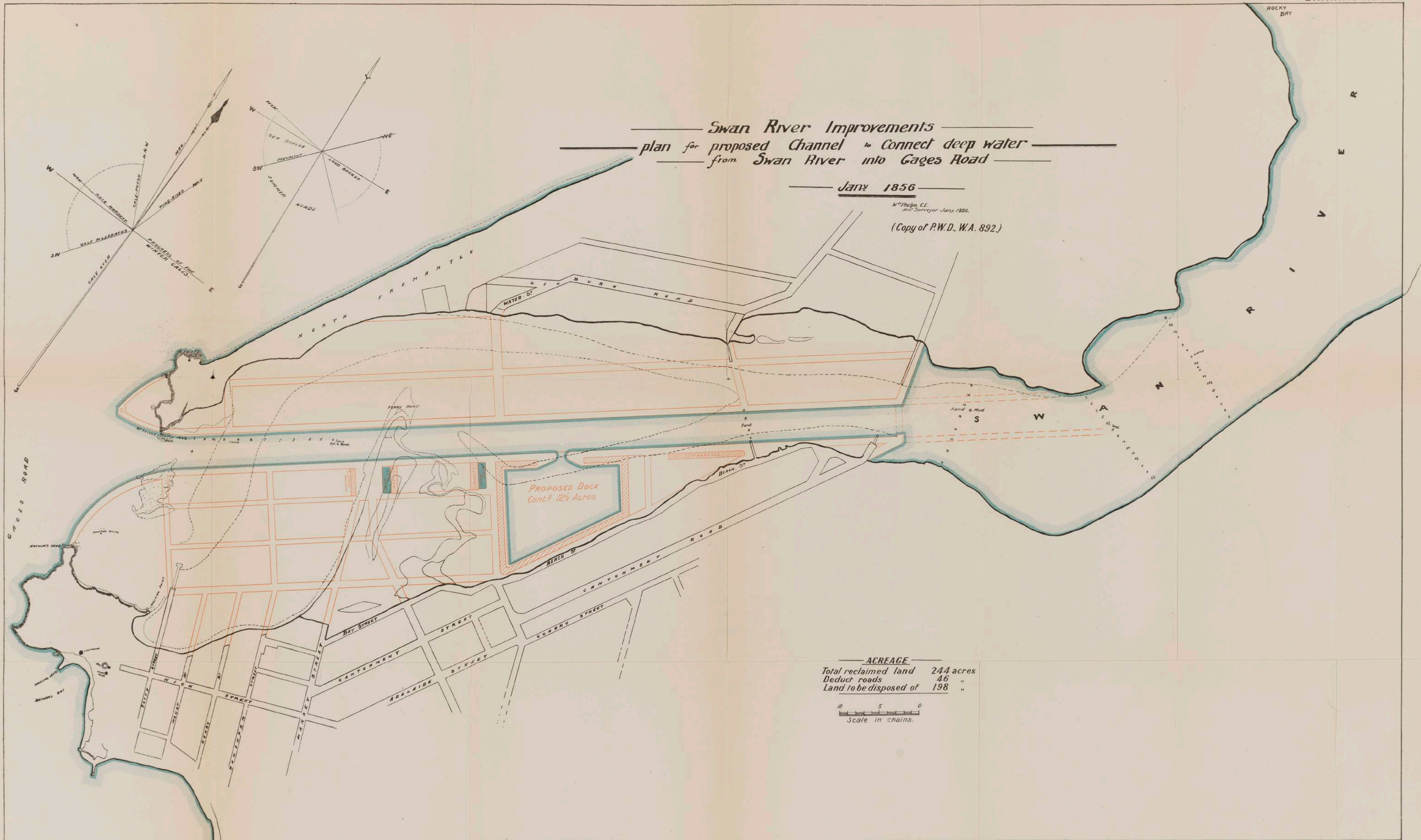
# Improvements to Swan River Navigation. 1830 - 1840.



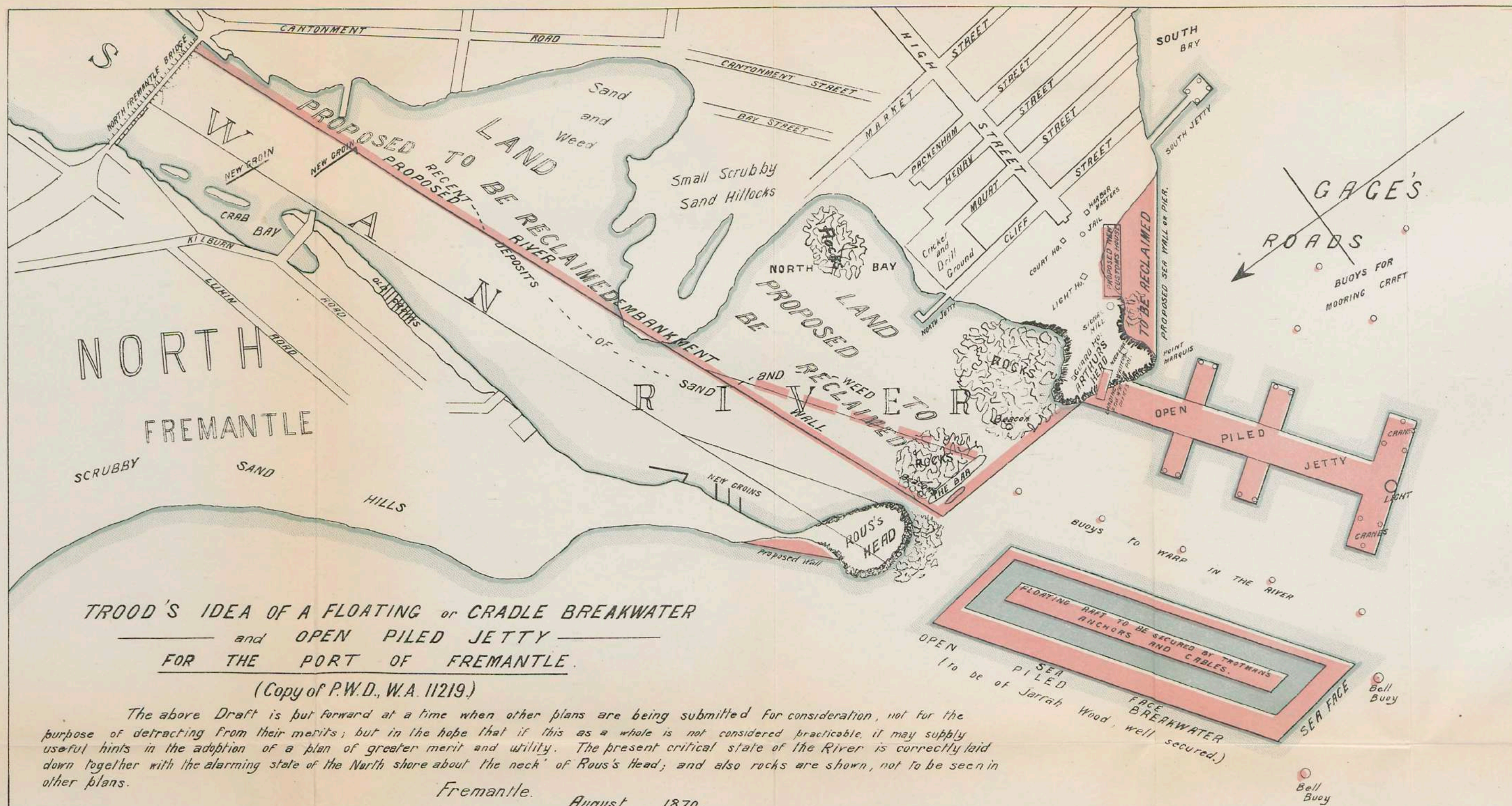












Memo:- "Arthur's Head to be cut away to the level of the proposed New Jetty, which should be a moderate height above high water mark at that point leaving sufficient rock for the Light House &c. It is proposed to remove the powder Magazine from its present site to one more isolated under the proposed Works. The Sea Wall or Pier and Filling in for the Custom House &c. to be built with the stone raised from the levelling of "Arthur's Head".

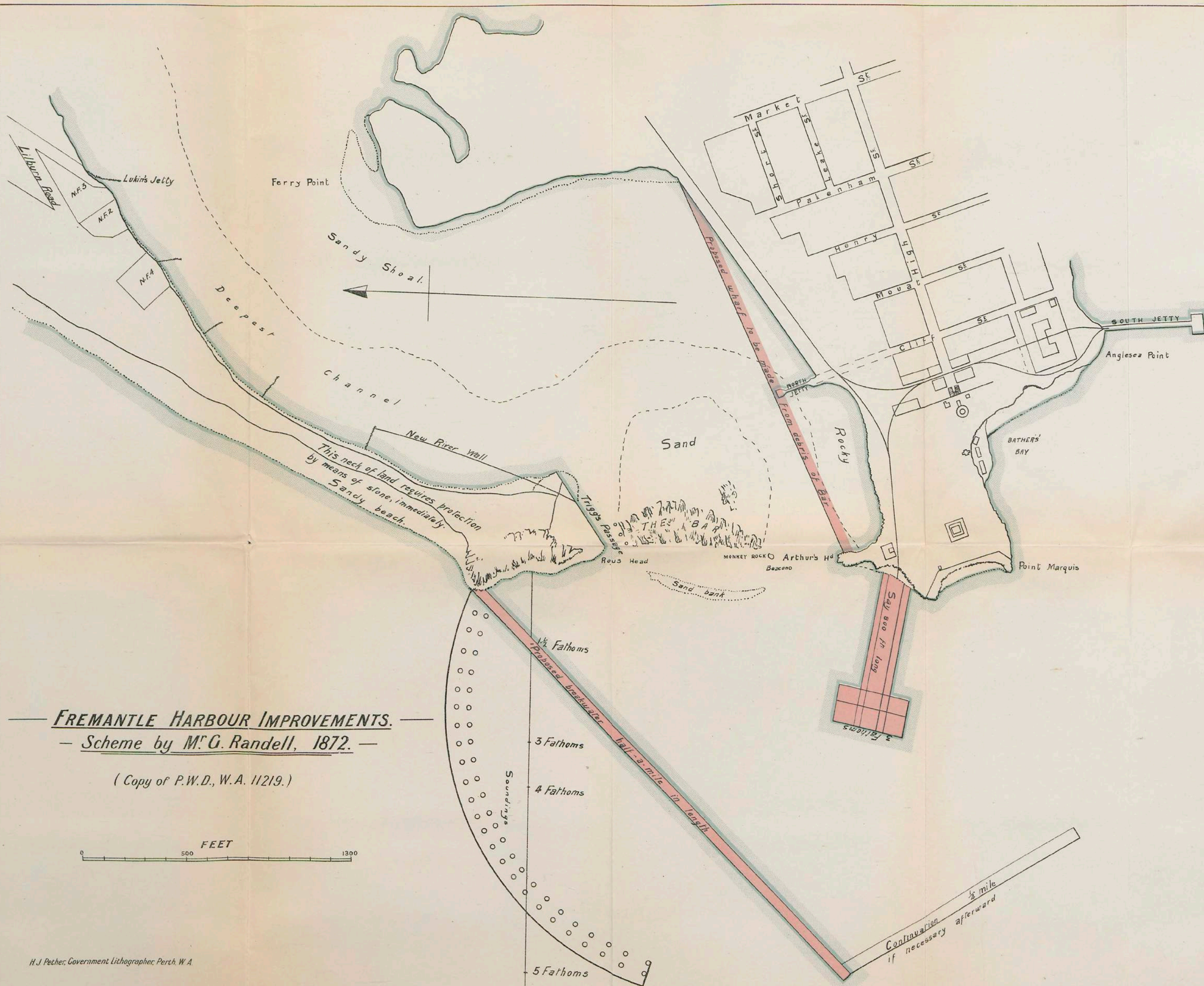
The open Piled Jetty which starts from "Arthur's Head" will be protected by the "Floating or Cradle Breakwater", with Piles so arranged to check the waves on the N.W. and S.W. sides-the Framework to be of sufficient height above high water mark, secured and fastened together properly. With the Framework and Cradle combined. Smooth water must be the result inside the "Breakwater", and the "Bar" will have its share. With our Timber and Convict labour, this work ought to be performed at half the cost elsewhere. Little more than "Trotman's" anchors would have to be imported.

When the above Works are completed (but not before) I would propose the undertaking of the River Improvements as laid down in the plan; and I consider the land "reclaimed" inside the River Embankment Wall, when sold, will cover the whole cost of the works. This done and a steam Dredge at work almost a straight channel can be got. The debris raised by the "Dredge" can be used in filling in the embankment reclaimed ground. The height of the embankment Wall should be brought to the level of Cliff Street, and extend up to the Bridge. The "Buoys" laid down to the "Bar" are to assist vessels against contrary Winds warping in or out, as the case may be.

If the above works are carried out, we may look forward to the day when vessels of 300 tons load and unload in Perth Waters, by only keeping the Dredge at work, clearing the Channel, and the reclaiming of land pursued.

Presented to His Excellency The Governor  
by Edward T. Troode





**FREMANTLE HARBOUR IMPROVEMENTS.**

— Scheme by M<sup>r</sup> G. Randell, 1872. —

( Copy of P.W.D., W.A. 11219. )

FEET  
0 500 1300



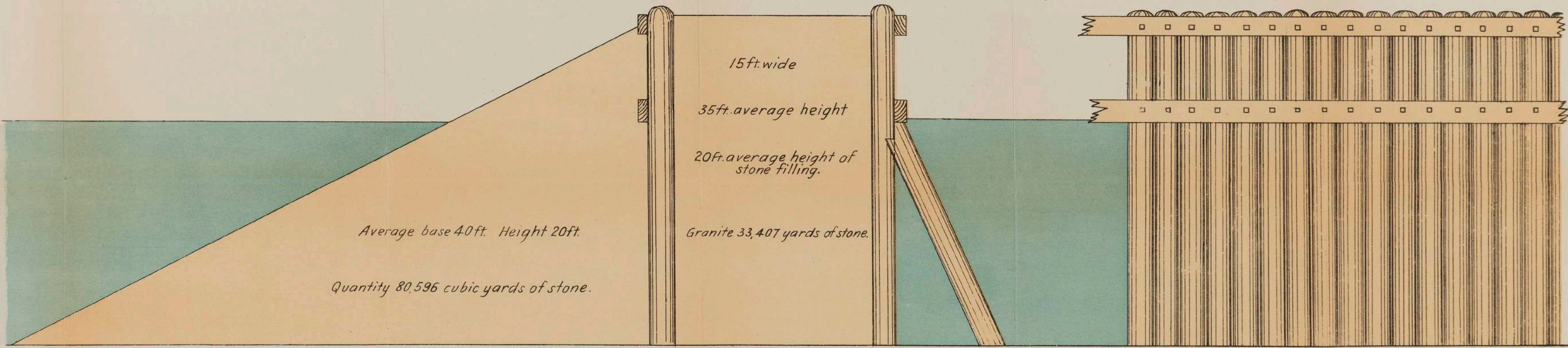
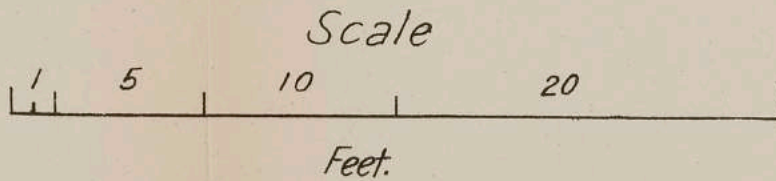
*Fremantle Harbour Improvements.*

*Scheme by Mr G. Randell*

1872

— Details. —

(Copy of P.W.D., W.A. 11219.)



*Section.*

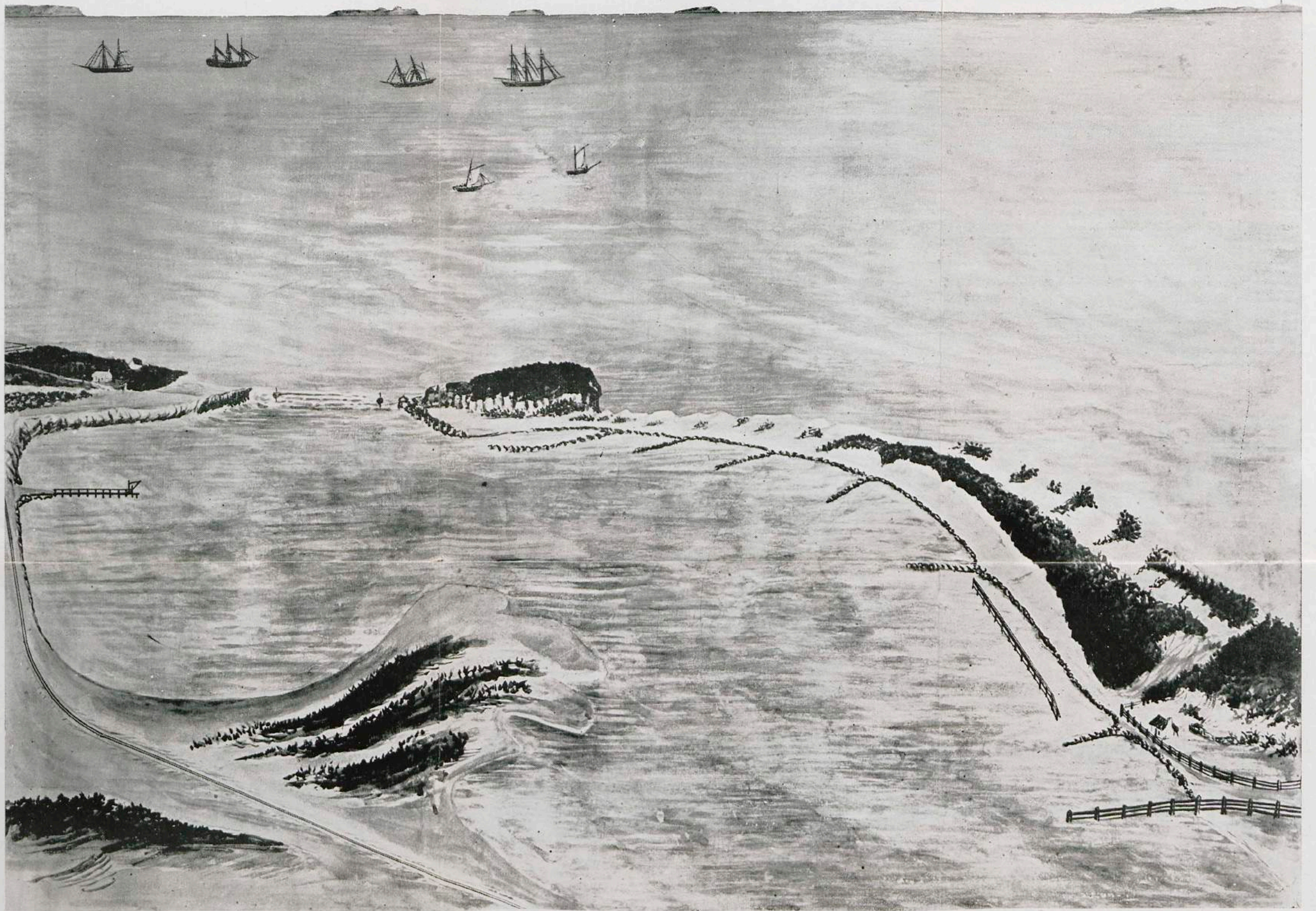
*Elevation.*



# Proposed Dock and Harbour at Fremantle, W.A.

Design by Thos. H. J. Browne, C.E. April, 1875.

Drawing No. 6.  
Sheet No. 1.

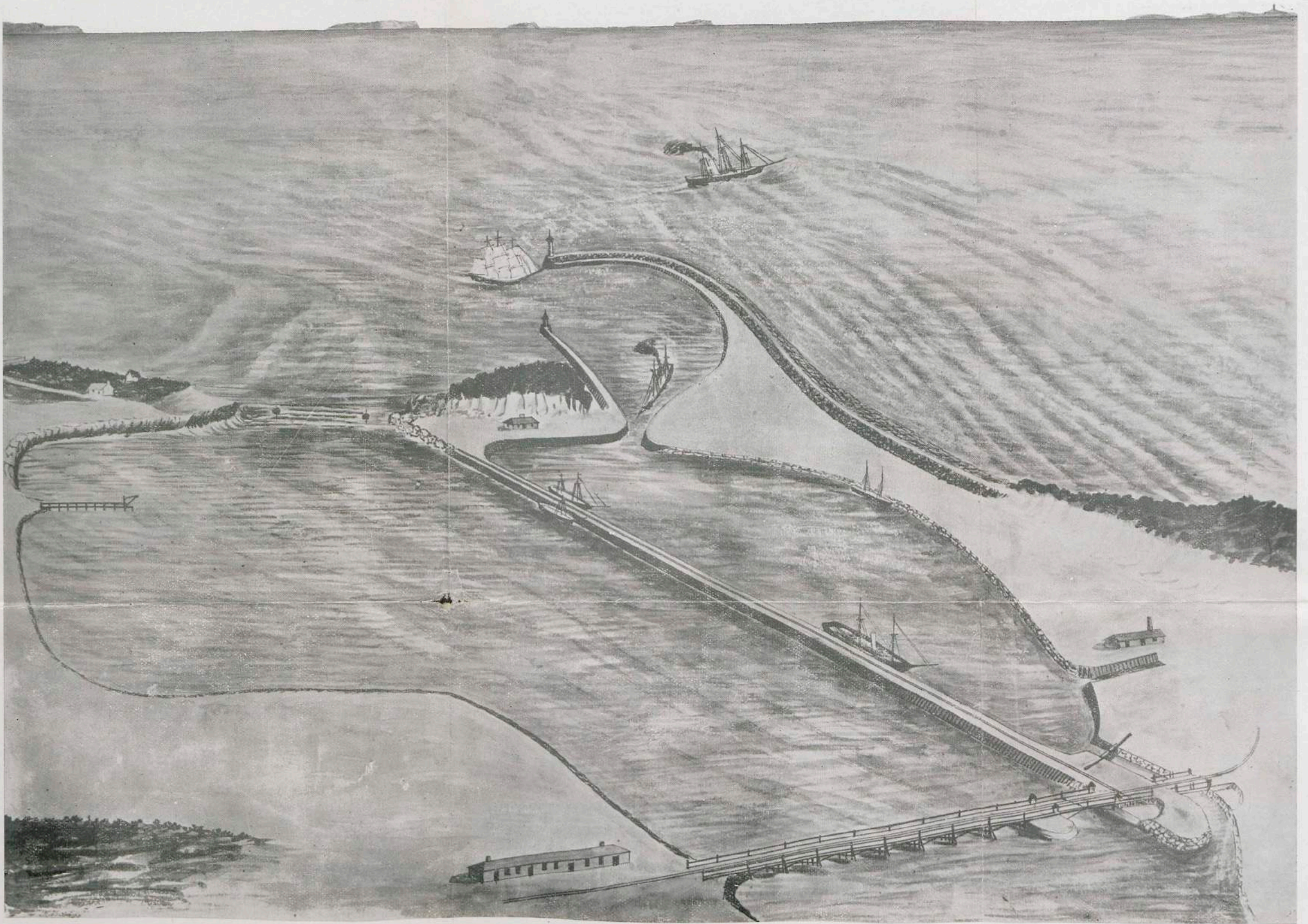




# Proposed Dock and Harbour at Fremantle, W.A.

Design by Thos. H. J. Browne, C.E. April, 1875.

Drawing No. 6.  
Sheet No. 1A.





PROPOSED DOCK AND HARBOUR AT FREMANTLE W. A.

ORIGINAL

DESIGNED BY THOS. J. BROWNE C.E.

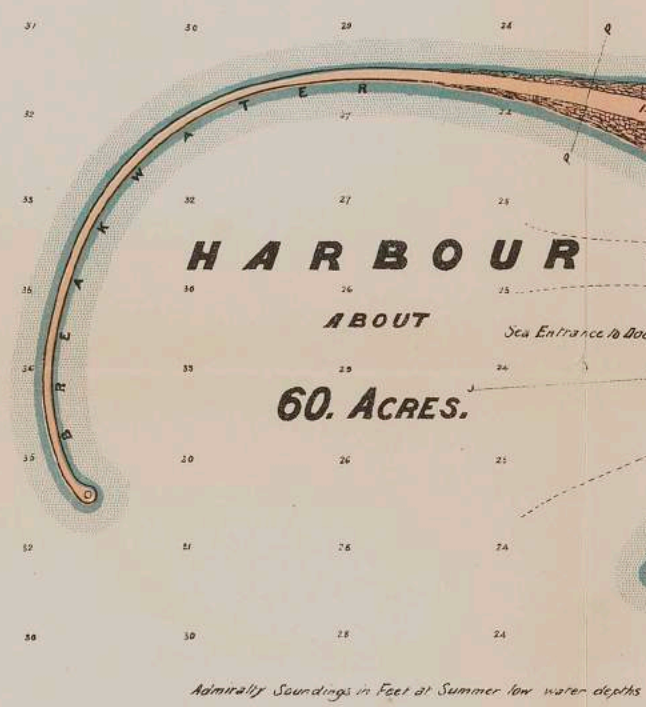
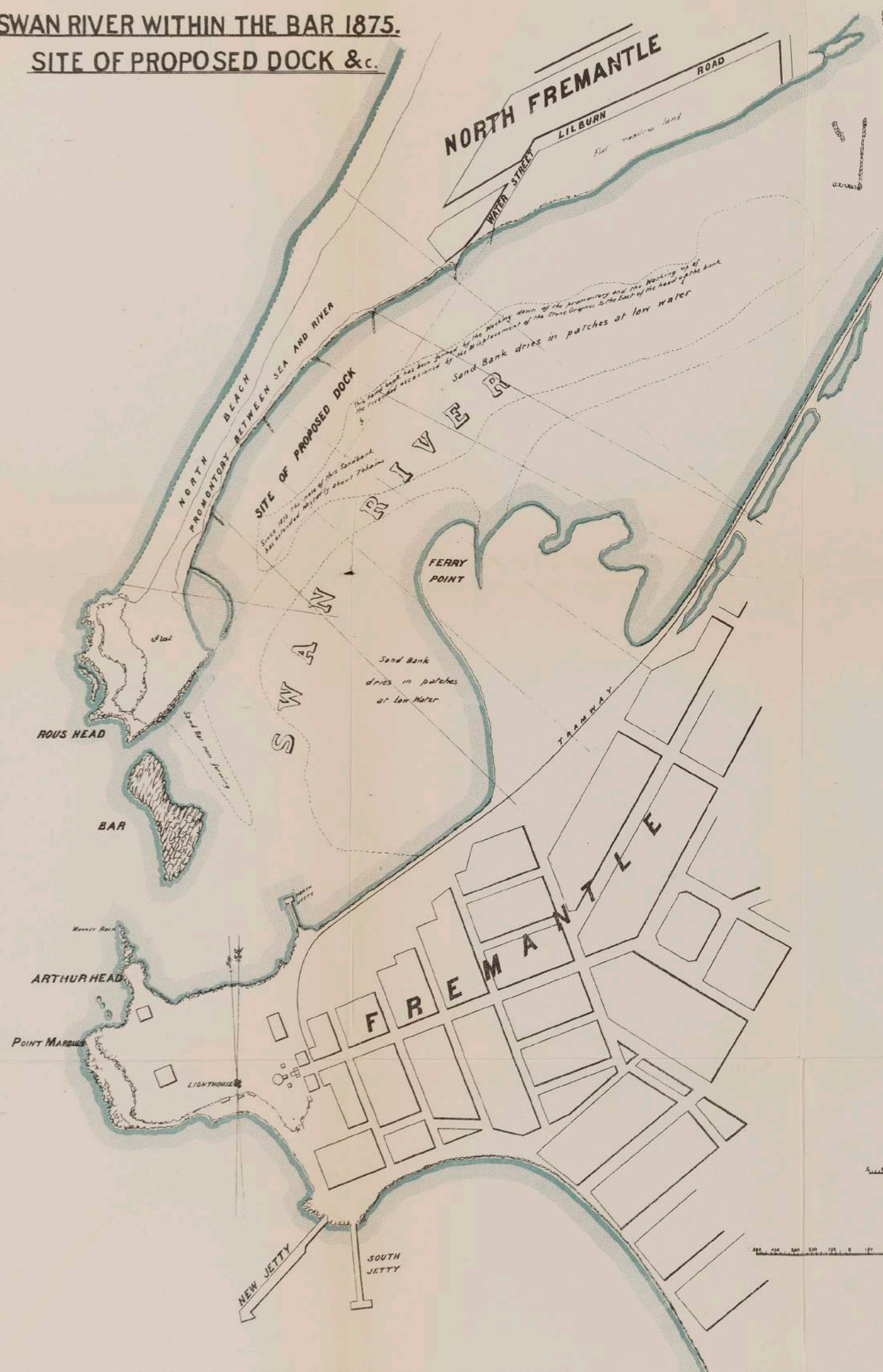
GENERAL BLOCK PLAN OF PROPOSED WORKS

APRIL-1875.

(Copy of P.W.D., W.A. 11219.)

SWAN RIVER WITHIN THE BAR 1875.

SITE OF PROPOSED DOCK &c.



SCALE OF CHAINS

SCALE OF FEET

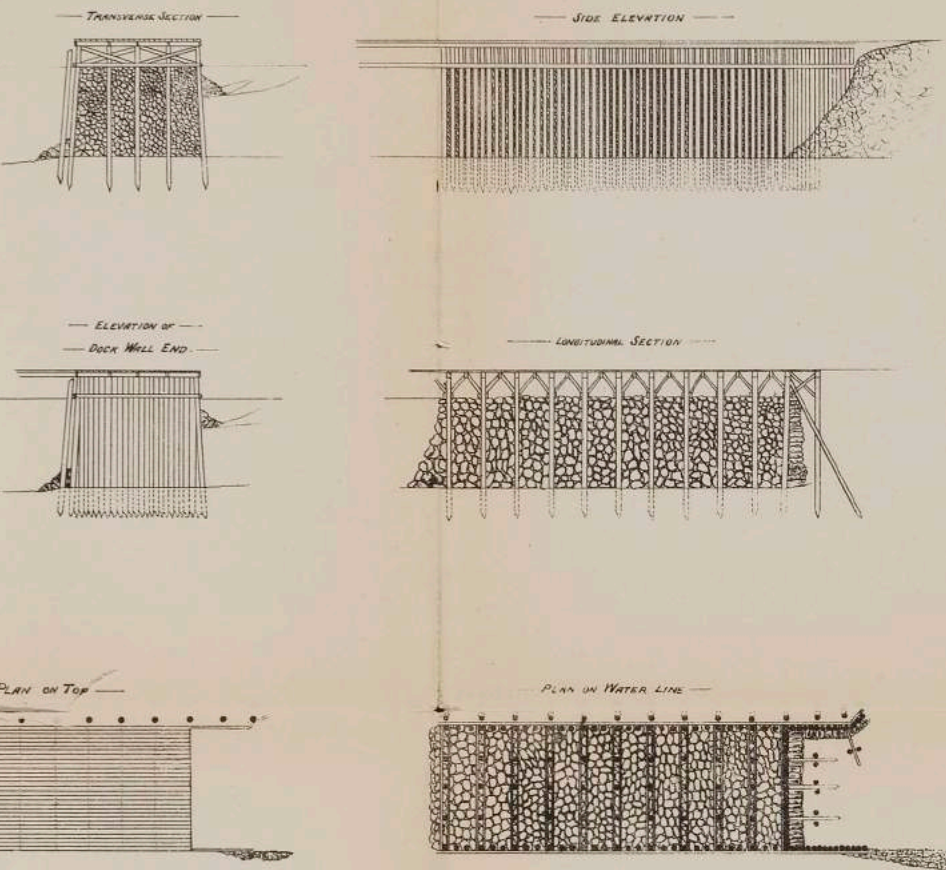


Drawn from previous survey of the River  
By Thos. J. Browne  
Fremantle, October 1875

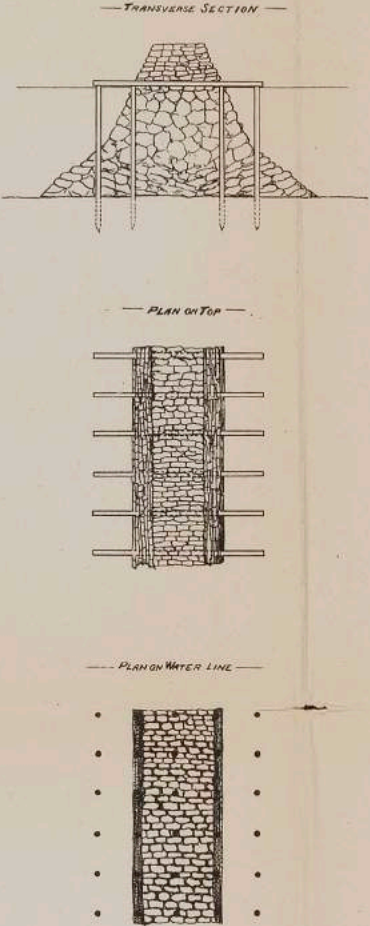


PROPOSED DOCK AND HARBOUR AT FREMANTLE. W.A.

DOCK WALL

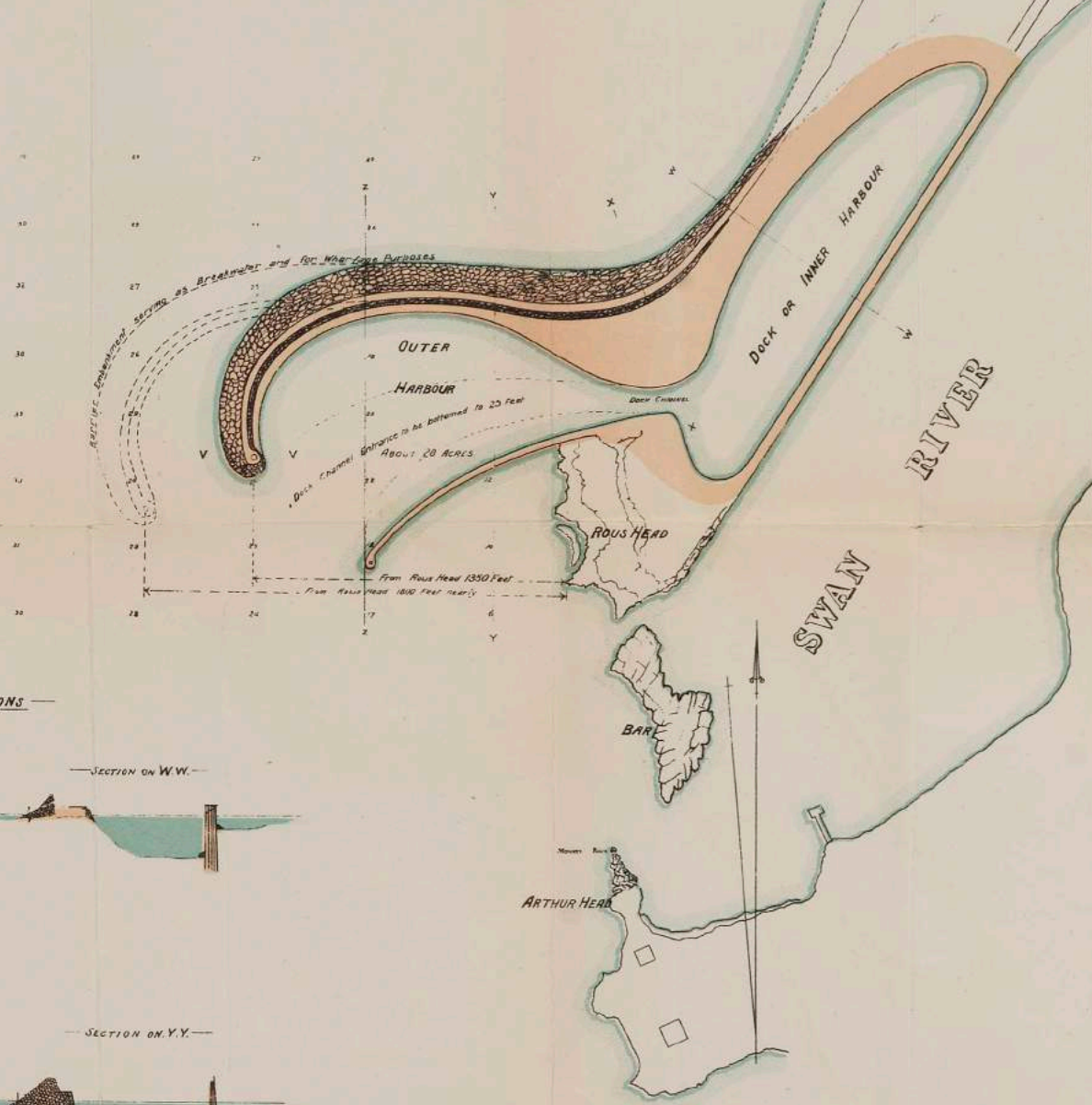


DESIGNED BY THO<sup>s</sup> H. J. BROWNE, C.E. APRIL 1875.  
(Copy of P.W.D. W.A. 11219.)  
**BREAKWATER.**

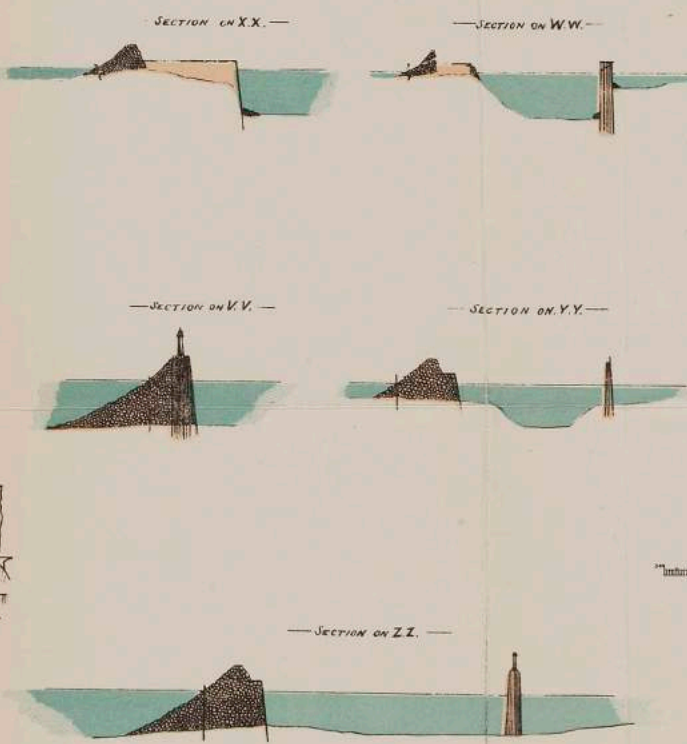


MODIFIED PLAN OF DOCK AND APPROACHES.

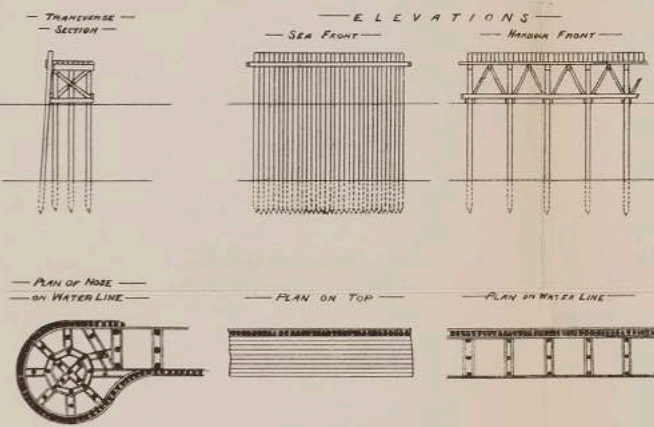
AN OUTER HARBOUR FORMED BY ALTERATION OF THE BARRIER EMBANKMENT.



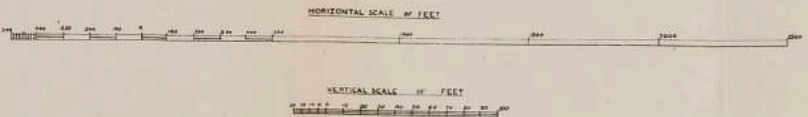
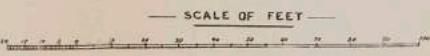
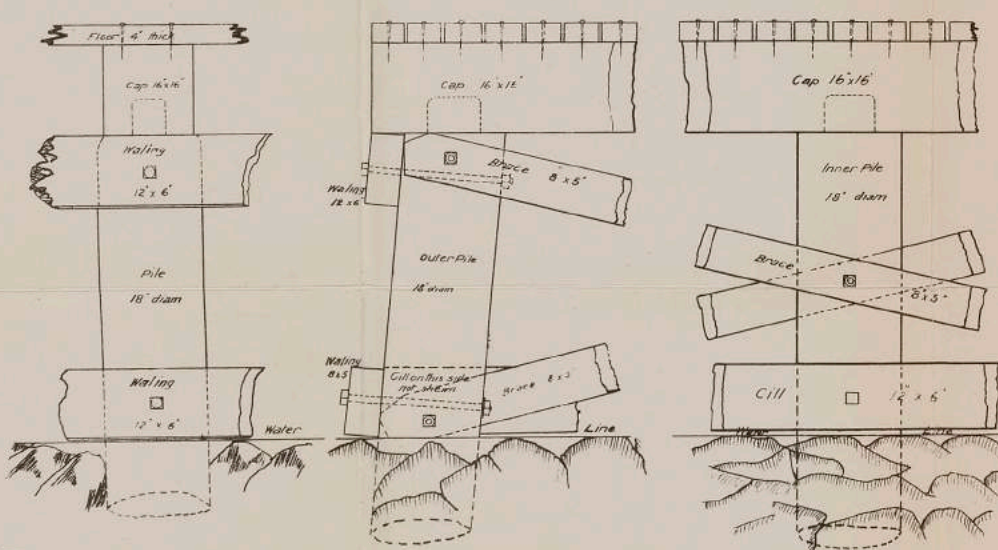
SECTIONS



GUARD PIER.



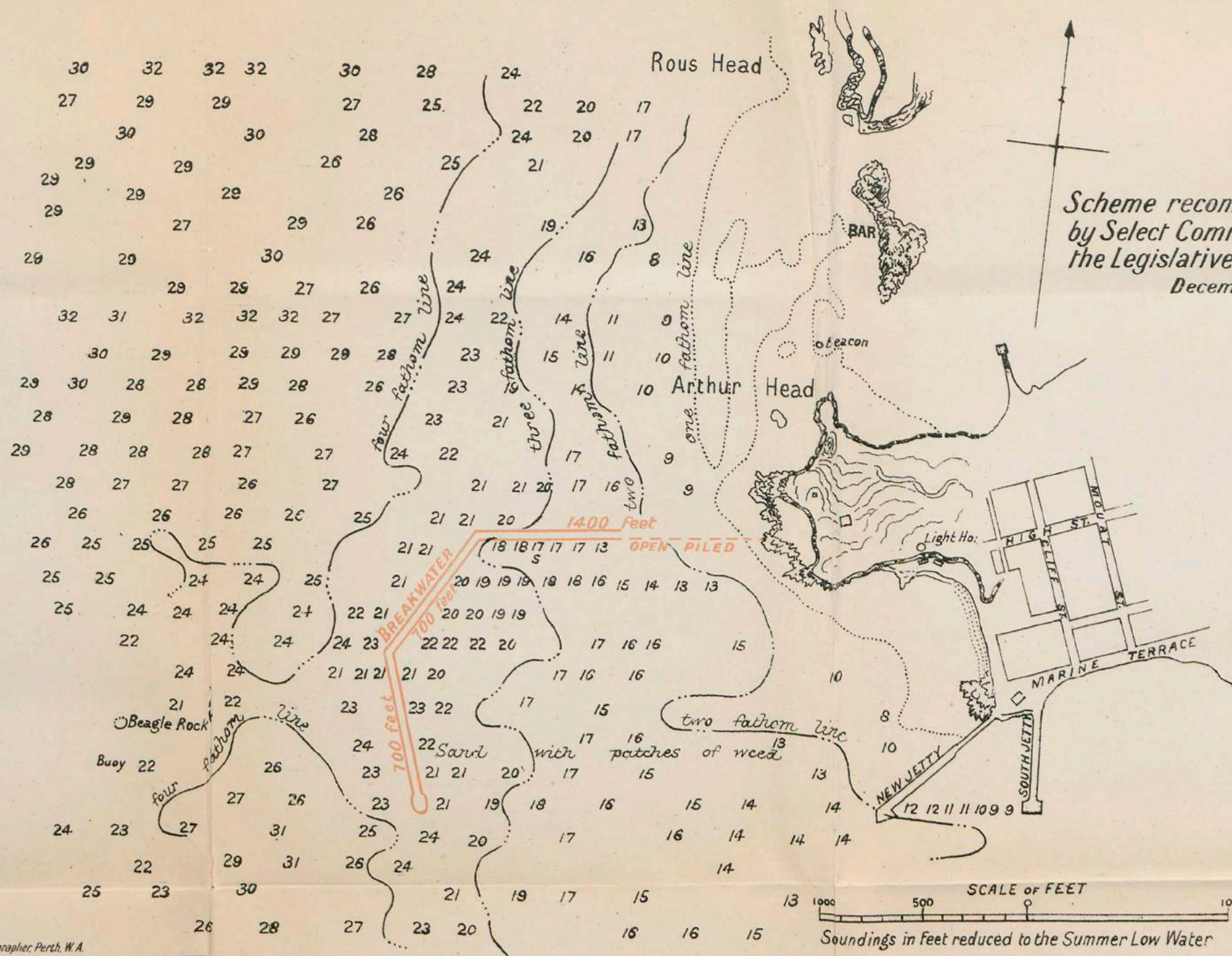
DOCK WALL TIMBERS ENLARGED SIZE





H. J. Pether, Government Lithographer, Perth, W. A.







# FREMANTLE HARBOR,

Western Australia.

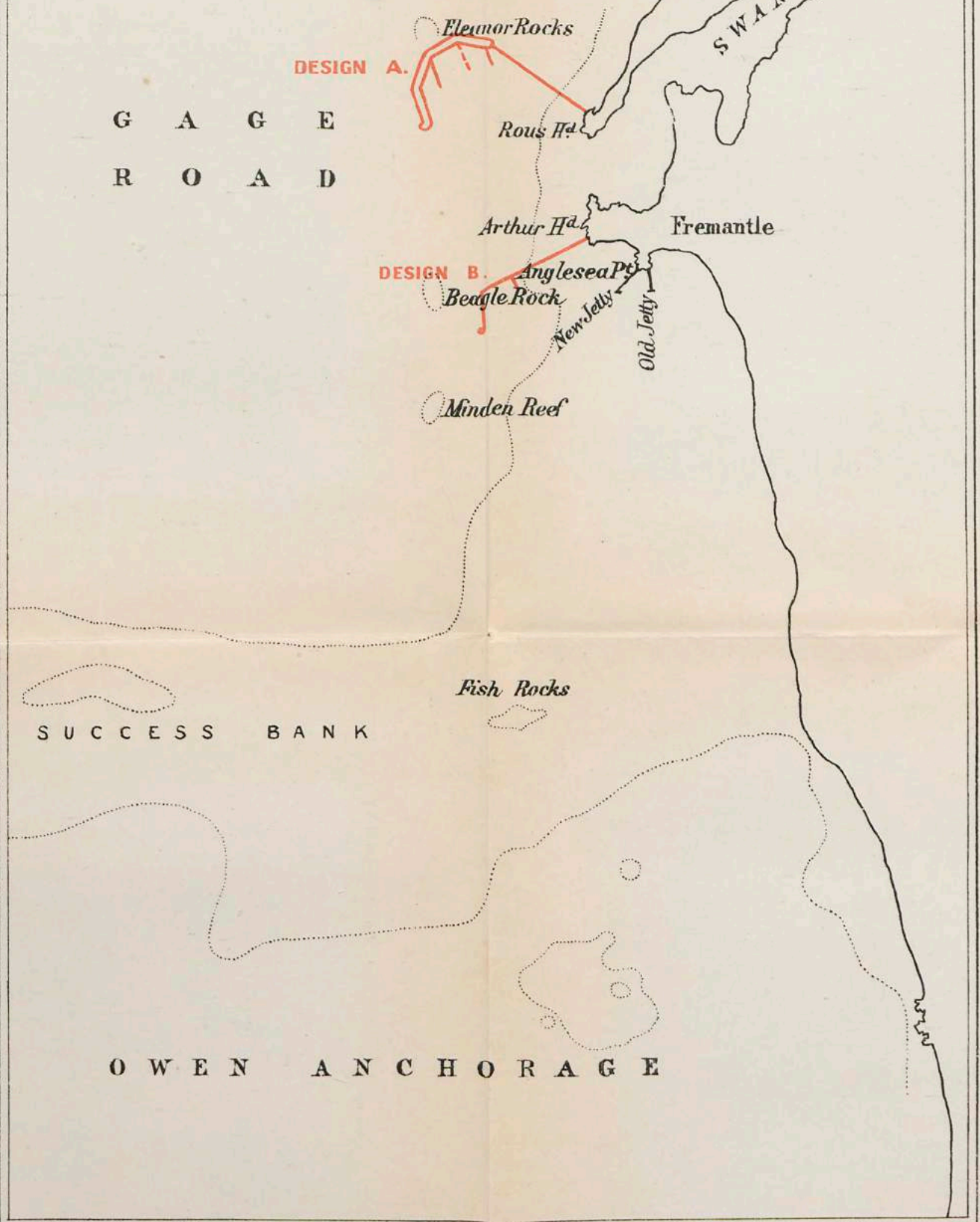
## PART OF KEY CHART

ACCOMPANYING

Sir John Coode's Report,

Dated 13th Nov., 1877,

Showing Designs A and B.





# FREMANTLE HARBOUR AND GAGE ROADS

Surveyed by Nav<sup>o</sup> Lieut<sup>t</sup> W.E. Archdeacon, R.N.

Naval Lieut. J. E. Coghlan, R.N. 1874  
*The Emerald Hawk* made by G. T. Gossard. Dept. of C. F. Fisher. *Hawks*, 1878.  
 Light-house, Lat. 32° 23' N. Long. 122° 41' 23" E.  
 H.B.C. C. Inequatorial. *Hides* none. 24 27  
 Light, E. Road, P. Flashing, Rev. Revolving  
 Buoy, B. Black. R. Red. W. White. Chg. Chequered  
 course. 1 fine, 3 grey, 1 m. med. weak, 1 small. 1 shell, 1 velvet  
 All heights are expressed in feet above H.W.  
*Magnetic Variation* in 1875, nearly stationary.

SOUNDINGS IN FEE

The straws, thus ~~-----~~ show the general direction of the currents, which are greatly influenced by the prevailing winds. The direction of the outflow from the Suez River, during the winter months, and after heavy rains, is noted thus ~~-----~~

**Time Signal**  
A ball is dropped at Arthur's Head,  
at 1<sup>h</sup> PM West Australian mean time  
corresponding to 1<sup>h</sup> 0<sup>m</sup> 0<sup>sec</sup> GMT.

*Sir John Coode's design 1887 shown in Red and Green Colour.  
Works in full Red lines & coloured Green to be undertaken forthwith.  
Works in broken Red lines provide for future extension.  
M.C.Y.O'Connor's original scheme shown in Blue Colour.*

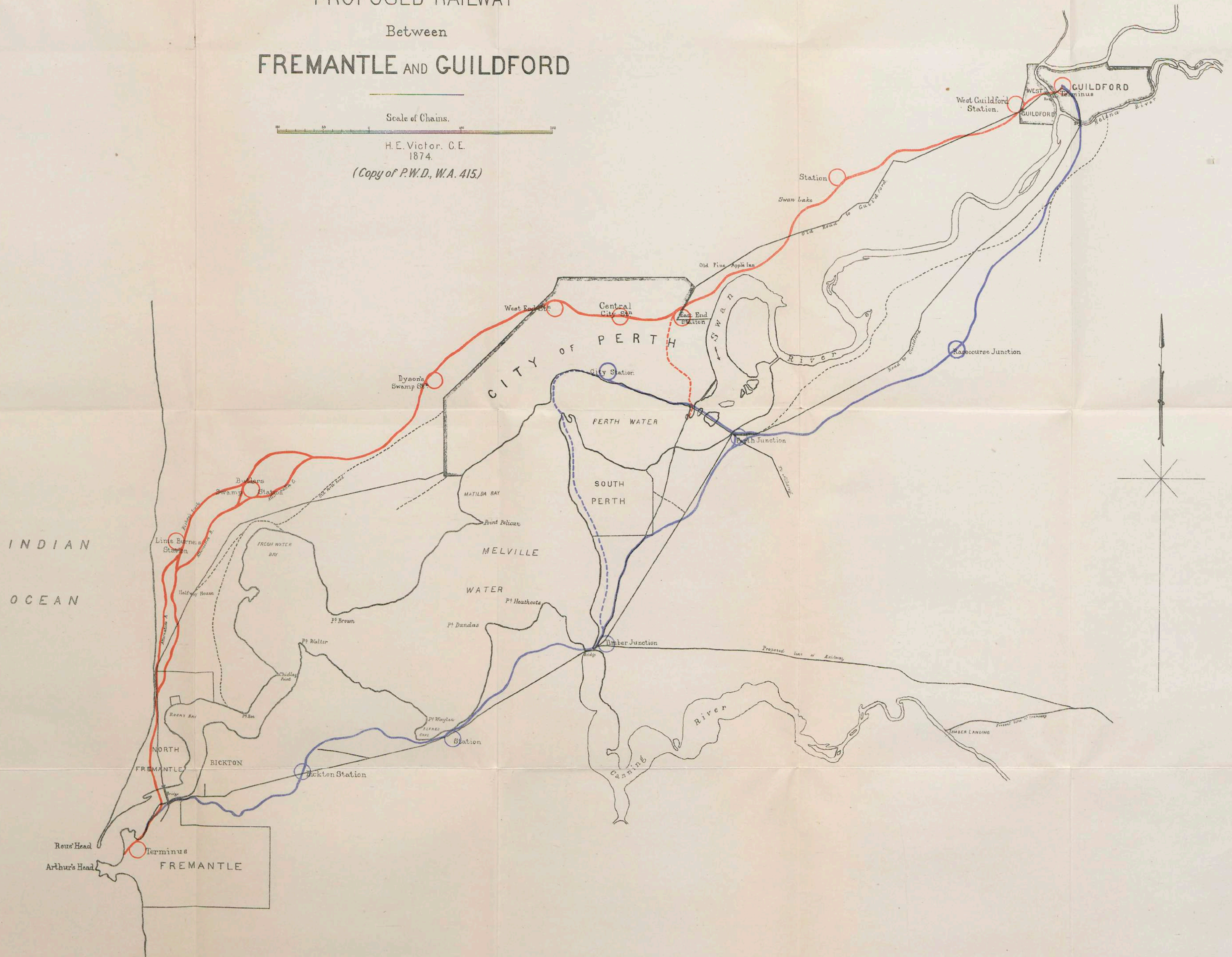


PROPOSED RAILWAY  
Between  
FREMANTLE AND GUILDFORD

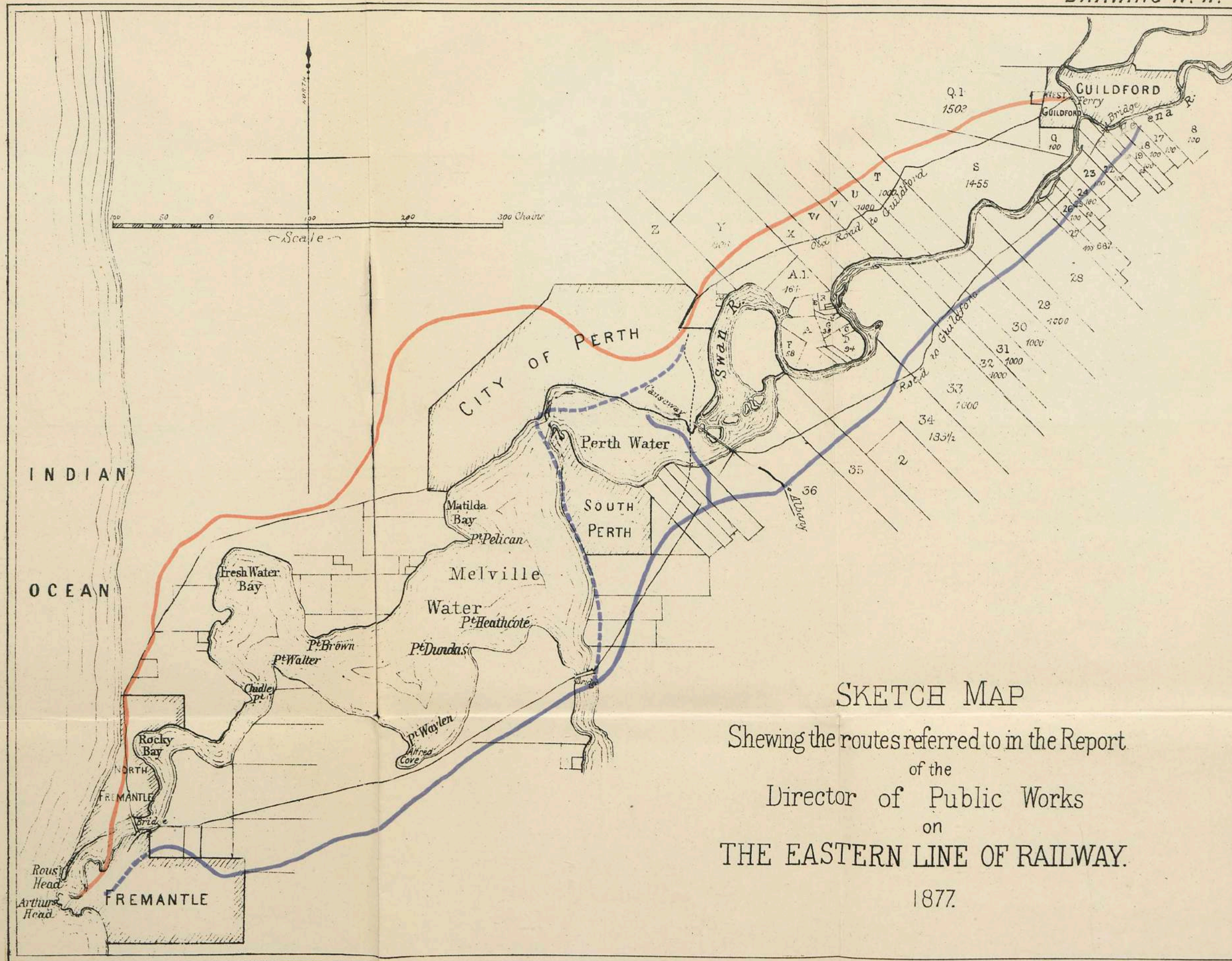
Scale of Chains.

H. E. Victor. C. E.  
1874.

(Copy of P.W.D., W.A. 415.)







## SKETCH MAP

Shewing the routes referred to in the Report  
of the  
Director of Public Works  
on  
THE EASTERN LINE OF RAILWAY.  
1877.









V. K. JONES & CO.,  
PRINTERS,  
859-861 HAY STREET, PERTH. W.A.

